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THE WORLD'S INDUSTRIAL AND COTTON CENTENNIAL EXPOSITION.

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The city of New Orleans occupies a section of low ground lying between Lake Pontchartrain on the north and the Mississippi river on the south; but the latter is a very irregular boundary line, of which the general course within these limits is easterly, with the usual meanderings to the north and south which almost everywhere characterize the Father of Waters.

There has been an evident effort to follow the course of the river in a series of streets which extends back in a line perpendicular to its banks for nearly a mile; but after that distance the parallelism becomes less and less rigorous, until finally the lake's shore gives the direction to the thoroughfares. The manner in which these two systems blend into each other is quite interesting, and reminds one of the gradual transition of curves to a straight line which is so often seen in the folds of thick masses of rocks, and may be produced artificially by bending in different directions a thick bundle of sheets of paper.

It would take too long to describe all the features of the exposition grounds, with the exact bearing of one point from another. In general terms, the grounds are about half a mile long (east of north and west of south) and a quarter of a mile in a direction transverse to this. These distances are merely rough guesses, rendered necessary from

the fact that there is no scale of feet on the map of the Exposition and grounds which has been issued for the use of strangers, by the Department of Installation under the direction of Mr. Mullen. The distances which I have given are probably too small.

The main building is of wood, painted a subdued pink somewhat like the sides of the International Electrical Exposition building in Philadelphia. It is somewhat larger than the main Exposition building of the "Centennial," by reason of a greater width. It is not easy at the first glance to say which is the length and which the width of the New Orleans main building. Viewed from the top of one of the towers, it presents the appearance of a group of separate wooden roofs, of which the eaves touch, and all have been exposed to the same snow storm. In fact, to make them water-tight, the roofs have been smeared with tar (or some similar substance) and then covered with paper boards, which have again been coated with the same material. The whole has been treated when dry to a partial whitewashing; but this part of the operation has not been thoroughly carried out, and the whitewash only appears in large spots over the surfaces. The first impression which a sight of these roofs makes upon the stranger is their great danger from fire. Of course in such an Exposition there are numerous fires, which send forth from their chimneys the usual products of soft coal, which is the universal fuel, *i. e.*, heated smoke and frequent sparks. It would seem that any sparks falling on the inflammable material which constitutes the roof, might easily set it into a blaze; and if this were done, its extinction would be almost impossible.

North of the main building is the so-called "United States Building," in which there are many very interesting exhibits, arranged with some system. Between the two, and near the western limit of the grounds, are three long low sheds (or, properly speaking, four, since the southernmost of the series consists of two parallel and independent sheds), each about 430 feet from end to end. These are designed for exhibits of stock of all kinds, but at present* are hardly occupied. The middle of the three contains 60 stalls on a side, each stall being about six feet in width. At present there are a couple, each, of Suffolk, Cheshire, Duroc, Jersey and Berkshire hogs, all exhibited by Mr. J. B. Mead, of Randolph, Vt. The southern half of the west-

* March 8 to 20.

ernmost of the two southern sheds contains a very interesting, but not very large, collection of cotton. The specimens were principally from Louisiana and South Carolina, though other districts were represented. The northern half of this shed contained a few cattle and horses, which either were not intended as an exhibit, or were the unreclaimed part of a cattle exhibit which had been held there previously. The easterly of the two sheds contained the remains of a bench show of dogs—a not very numerous remainder.

These outlying buildings, with a furniture building to the east of them and near the eastern extremity of the grounds, the Art Gallery; two long and slender sheds which stretch to the south of the main building and are called the Machinery Buildings; a separate wooden pavilion bearing the name of the "Department of Public Comfort," but in reality containing only a rather modest restaurant; a beautiful pagoda built by the Mexicans, but not yet occupied by their minerals, to which it is dedicated at the period when these notes were taken; and the long narrow green-house which is called Horticultural Hall: these comprise all the buildings located on the grounds.

The means of transit are either by one-mule car, on St. Charles street or Magazine street, or by steamer, or by private carriage, at $5. To these the writer, in spite of the expostulations of some kindly disposed natives, added a fourth, viz., by walking. The distance from the centre of the main building to the centre of New Orleans, or to the corner of St. Charles and Canal streets, was said to be about seven miles, and this estimate is not very far out, to judge by the time of walking it. By far the most agreeable way to get to the exposition, however, is by the steamer, which takes about ¾ hour to go, and 25 minutes to return to the levee at the foot of Canal street. By this means one is always assured of a seat and of the cool breezes of the river, which are not to be scorned, even in mid-winter.

On landing at the exposition grounds one is confronted by a species of wooden gate-house, of a pinkish color, in the form of the turreted castles which generally form part of a child's Noah's Ark, but this real one (which is larger than those) must have been divested of one wing. In striking contrast with this nightmare of the lumber yard, is the neat cottage building which, lying a short distance to the left, shelters the two handsome Worthington pumps. These supply the Exposition with water, each of a capacity of 1,000,000 gallons (3,785·21 cubic meters or tonnes) of water per diem.

About 150 meters or yards north by east of the landing are two sheds, which contain machinery, of which one is open and the other covered, and both connect with the main building. To the west of these are two small structures, designed to illustrate the methods employed to dry timber. That one which is nearest to the landing is the "Excelsior and Chicago" dryer; the other is the "Invincible." The principle employed in both seems to be the same, *i. e.*, a heating apparatus below a small frame building, in which latter the boards to be dried are so stacked as to allow the hot air produced by a system of steam pipes to pass in succession over every part of the material.

The Mexican exhibit in the long greenhouse, as elsewhere, was fine in what was shown, but the varieties of Mexican plants which might have been expected were not to be found. The Maguey plant and the cactuses, however, were very interesting. The other exhibits were surprisingly meagre, in spite of the manifest advantages which its climate conferred on New Orleans for such a display. Colorado, Wisconsin and Iowa had collections of apples, which probably had been once good, but when viewed were all more or less rotten. Florida showed the shaddock, oranges and lemons. Louisiana and Kansas also had exhibits which were fair in comparison with the rest; but it must be confessed that the general impression left upon the mind here is that of disappointment.

The easternmost machinery wing, which has been already alluded to, is built of corrugated iron, and bears the name of S. C. Forsaith, Manchester, N. H. Both of these wings are about equal in length, *i. e.*, 100 meters or yards, and each has a width of about 20 meters or yards.

The cotton press of S. B. Steis and others challenged the first attention, and the exhibit of George V. Cresson, of the Philadelphia Shafting Works, was worth a careful examination. It should have been said that in front, or rather on the river side of the entrance to the machinery annex, stands a small kiosque, containing the exhibit of the "Diamond Prospecting Company," which is the agent for the Sullivan diamond drill. The exhibit shows a portable engine, with lowered smoke stack, attached by steam pipes to the drill, which latter, however, at the times of several visits, was not in operation. The advantage claimed for this machine is that it employs a single hydraulic cylinder, with the drill rod carried up through the piston rod, instead of the two cylinders, with the drill rod outside, or of "an objection-

able positive feed." An additional advantage is that whereas other drills are sold subject to such onerous conditions that the purchaser hardly knows what rights he has acquired by the purchase, the owner can do what he chooses with the Sullivan drills, and sell them whenever he is so disposed. The "A" machine drills a hole, $1\frac{3}{4}$ inches in diameter, to a depth of 1,100 feet, and takes out a core $1\frac{3}{10}$ inches in diameter. Its price is $2,500. The "B" machine drills a hole, 2 inches in diameter, to a depth of 2,000 feet, and takes out a core of $1\frac{3}{8}$ inches diameter. Its cost is $3,000. The drills are sold *outright*, without any restrictions. (The agencies are: Chicago, 176 Dearborn street, room 16; Denver, Col., in the Colorado National Bank building; and Ottumwa, Iowa, corner of Main and Market streets.

The handsome Mexican Pavilion stands about 300 meters or yards east by north from here. It is of Moorish design, reminding one of the Pavilion which Mr. Furness built for the Brazilian Commission in the main building of the Centennial Exhibition, except that the Mexican structure is very much smaller, and stands out in the open air, apart from any other edifice. It is surmounted by a dome of glass, which in its turn supports an eagle.

South of the southern extremities of the machinery annexes, and between them and Horticultural Hall, are the frames for the fireworks. The "World's Tea, Coffee and Lunch Stand," too, ought not to be passed by in silence; for, if it be a very small booth, it enjoys a large name. I copy a part of its bill of fare, posted conspicuously on the ouside:

Ham sandwich	10 cents.
Corn beef, cheese, cake, tea, coffee, and milk	10 "
Chocolate, pork and beans	15 "
Bread and butter, eggs and celery	10 "

"WELCOME."

The façade of the main building is of a pale pink, with brown facings, and all of wood. On entering the building by the middle door, on the south, one observes on either hand a medallion of sheet metal, colored green and set in a rim of reddish brown wood. They appear to represent coats of arms, but their identity could not be made out, and the guardian of the public peace on duty in that neighborhood resented somewhat scornfully the imputation that he should know to what they referred.

On entering the main building by this door one is dazed, as usual

in large fairs, by the enormous extent of the covered show, and does not know whether to go to the left, right or straight ahead. Among the first objects to rivet the attention at this point is the fanciful dragon on the Chinese exhibit. This monster is made of sheet metal, and colored in that terrifying manner which only the Chinese understand.

The record of observations must necessarily be desultory, since the objects themselves are placed on the floor with very little regard to system, so far as the writer could discover. It is true that several things of the same kind are sometimes found near to each other, but the reverse is more frequently the case. Among the most interesting of all the collections witnessed by the writer, is the Japanese Educational exhibit, near pillar NN—10. The merit of the exhibit deserves all the more praise from the fact that the invitation of the General Government, and especially of the Interior Department, to participate in this Exposition, was only received by the Japanese last August. No more than the briefest sketch can here be given of it, though it is one of the most instructive in the whole Exposition. It is well divided, and systematized too, as follows: 1. Children's toys, with bows and arrows for boys; and battledores and shuttlecocks, hand-balls and kitchen utensils for girls. 2. I-ro-ha-tato-hi-karuta (alphabet cards); "Syllabary" cards for the purpose indicated in their name and also for inculcating moral maxims; Natural History cards to play Japanese checkers with, and at the same time to learn the names of animals and other objects. 3. Sugoroka, a kind of Japanese backgammon (the varieties exhibited principally for girls, and designed to acquaint them with women celebrated for virtue, and also to instruct girls in the mystery of silk making). All these and many other similar objects are classed under the general head of "Kindergarten apparatus, and not with the following, which are more properly of use in the more advanced curriculums for educating the young:

A. The regulations of the Kindergarten attached to the Tokio Female Normal School.

B. Kindergarten toys, pictures; Kindergarten gifts; ruled blackboards; moral story charts; book on Kindergarten games, etc.

C. Work of the infants in the Kindergartens: Pea and straw work, etc.

Elementary Schools:

A. Photographs, ground plans, etc., of various schools.

B. Regulations of school management, etc.

C. School furniture and apparatus, desks, chairs, drawing instruments, blackboards, ink-boxes, luncheon-boxes, chop sticks, instruments for collecting and preserving insects, paper slates, paper blackboards, chalk, and water-writing copy books. These latter are sufficiently ingenious to merit a few words. They were invented by Mr. Ikeda Jetsutaro and their peculiarity is that the characters are traced by a brush with water instead of ink. The writing remains long enough for the master to correct it, and then disappears entirely leaving the paper fit to use again. It is a sure preventive of the usual condition of boys' hands and faces; though the natural talent of the average small boy to get dirty would doubtless not be seriously hampered by the shutting off from him of this means.

D. Elementary school apparatus, geometrical models, models of clocks, abaccus, etc., minerals, astronomical models, geographical model. The physical apparatus is very ingenious and noteworthy. It has been manufactured by Kiôikuhin Seizô Gaisha (a private company in Tokio). It is made almost exclusively of bamboo, and where such flexibility is required as the reed itself does not afford, a number of small pieces of bamboo are attached together by small sections of gum tubing, the whole making a system which appears to fulfil all the requirements of connecting air passages for air-pumps, etc. The greater number of the pieces of apparatus shown, were made by the students of the Tokio normal school, under the direction of their instructors, who thus provided them with the best possible manual practice, and at the same time an invaluable experience of the various physical agents under a variety of circumstances.

E. Educational works for school use. Among the various text-books, native and translated from foreign sources, one notices Roscoe's Elementary Chemistry and Cooley's Easy Experiments in Physics. There is also the Hokkai Shobunten (or grammar of the languages used by the inhabitants of the Yezo), concerning which we are told that these inhabitants are ignorant of letters, and speak a language peculiar to themselves. Hakodate-ken therefore arranged the two languages (it is to be supposed of the other parts of Japan and of Yezo) side by side, in order that those who were ignorant of letters might read the differences between their native tongue and that of the polished Yeddoan.

F. This division is taken up with the work of school pupils.

G. This is devoted to tables showing the standing, etc., the physical growth and development, the weekly record of the elementary school

attached to the Tokio normal school, and the specimen register of the pupils of the same school.

Similar categories are given of the secondary schools, the higher female schools, the "schools of female handiwork," and gymnastics. In this latter exhibit there is one series of views representing the game of "Dakiu" played by schoolboys on foot, which bore such a distinct resemblance to "Shinny," that the eye of everyone who had ever been a real American boy, sought it out with wonder and delight. The same game played by a set of tea-caddy figures on horseback gave an idea of the violence with which the Japanese enter upon sport, and bore an even greater resemblance to "Polo." Next came the professional schools illustrated by photographs, models, maps, their regulations, the work done by their students, and calendars and descriptions. After this came the higher education represented largely by exhibits illustrating the University of Tokio. With these exhibits was a mannikin made up of 100 pieces doweled together by small iron wires or rods, hooks, etc. Following these is a class showing the books and publications relating to the subject. Then comes an exhibit of musical instruments both Japanese and Chinese, and European. The last subject presented is that of reference books for those engaged in education, and the regulations of the Government regarding the whole subject. The whole exhibit is most creditable to the little nation sending it, and teaches us again that we have much to learn from our oriental cousins, even in those things which, at the same time, we are teaching them.

The exhibit which is sure to attract the most attention, and which has, perhaps, the merit of the greatest care and expenditure, and much more than the average taste and even classification, is that of Mexico. On entering the building by the middle door of the eastern side one sees at once the brilliant green, white, and red flags of Mexico intertwined over the whole of the area occupied by our sister republic, so that there is absolutely no difficulty in following the aisles from north to south, though it must be confessed that a very little additional care would have been blessed by every visitor who had a more serious object in viewing the collections than passing away his time. The lack of proper regard to any natural system of classification renders study unnecessarily difficult. The show-cases used are very similar to those employed by Germany at the Philadelphia Centennial. They are black, with a very slight relief of grooving and gilding to lift them out of the suspicion of having

once formed part of an undertaker's establishment. It may occur to the uninformed, too, that it is odd to see great trunks and slabs of trees equally with pyramids of sugar and bags of coffee locked up in these hermetically sealed cases; but in reality it is done in order to avoid any suspicion of violating the Revenue laws of the United States, it being known even down in Mexico in what horror we hold this particular sin. So that the light-fingered gentry may as well at once abandon all idea of secreting under their coats any of the 500 kilogram slabs of mahogany, etc. This pre-vision on the part of the authorities, and loyalty on the part of our neighbors, must have the effect of discouraging them.

Señor Eduardo Kuhn seems responsible for most of the exhibits of hard woods, and furniture made from them; and these articles form a very notable fraction of the Mexican display and are highly creditable both to the good taste and to the enterprise of the commission. There is, first of all, a large column of polished woods of Mexico (not in cases), and several special exhibits of ornamental carving, which are very beautiful. Among these latter may be particularly mentioned some ornamented, carved, picture frames, an inlaid table and a secretary, which resemble some of the masterpieces of Italian workmanship. Besides the foregoing, were various articles of dark wood furniture all bearing the name of Señor Eduardo Kuhn. Another exhibit (the first to strike the eye of the visitor entering the enclosure from the south, is the chocolate manufactory of the City of Mexico. It is thus explained to the observer:

"The Tabasco Flower. It is the leading and most favored fabric of chocolate in the Mexican Republic. First it made use of steam engine for the manufacture and was introducing in Mexico all improved machinery of the modern system. It has got the highest rewards in all Mexican and foreign exhibitions where his produces have been sent. At none in Mexico has been awarded so numerous premiums, of which there are the centennial medal of Philadelphia, and 14 golden medals. Ignacio K. Ferrer. City of Mexico."

Of course one expects to find the most beautiful Serapes, or Mexican blankets, in this exhibit; and one is not disappointed. There are some of these in the cases at one extremity of the space which for fine workmanship and beauty of coloring exceed any specimens of the kind which one would be likely to find in the whole extent of our sister republic. But the horsemen's hats, with their silver and gold embroid-

ered tassels, and their very ugly shapes, are not more elaborate than one can see in use in any of the larger cities of Mexico. Besides, they always are open to the suspicion of having been made by machinery in New England. The figures, which are usually ascribed to the Indians, are disappointing, *i. e.*, they are neither better nor worse than those which one finds everywhere in the shops of Mexico. Much more instructive is the display of the products of the various manufactures founded upon the Maguey plant (often called the American Aloe). Bags, hammocks, bull ropes, and harness are shown, which have been made of the "Pita" and Maguey. The whole display is highly creditable to the Mexicans, and although not very large compared to the resources of that growing State, and the facilities for sending its products to New Orleans, it is more comprehensive, better chosen, and better arranged than any single exhibit, or group of exhibits, in the United States space.

Among the few articles included in what, by a stretch of the imagination, might be called the British Department are, first, Henry Mann, Son & Co.'s Nonpareil Velveteen Works. The cloth is cut by a woman who explains the peculiar knife and mode of using it. The cloth is cut in "the gray state," and is colored afterwards. Another exhibit which, if not important, is at least not devoid of a certain attractiveness, is found also in the English department, viz., articles of slag for the table and mantelpiece, which is made to imitate the veining of marble, and agate. The articles are not as cheap as one might suppose they would be from their origin, but as a means of utilizing blast furnace slag (and other kinds), they illustrate a new industry which cannot be entirely neglected in even the most superficial view of the exposition.

The Chinese exhibit is to a large extent the counterpart of what it was at the Philadelphia Centennial, but has some new and admirable features. One of these consists in a series of life-size figures with very diverse facial expressions, representing the costumes and employments of the inhabitants of the Flowery Kingdom. Amongst the rest are figures representing the collecting, preparing and weaving of cotton; the costume of a Buddhist priest, etc. All these figures were exceedingly artistically arranged and draped, and as different as possible from the horrors representing the artistic taste of this, the most favored Christian nation, of which some will recall the "Signers of the Declaration of Independence" during the exposition of 1876, and all can see examples among

the exhibits of some of the Government departments, which will be mentioned presently. It does seem to the observing layman as if there must be something in the arrangement of figures to look like human beings, which menaces the liberties of the "Great and Free people" which we are apt to call ourselves. It is only on this ground that much of the art at Washington, and all of the lay figure productions of the Government can be accounted for.

One of the exhibits which ought to be well illustrated, and in fact does take up a great deal of room, is the industry of ice-making. Two or three machines (all more or less improved forms of the old Carré machine) are found (singular as it may seem) together, close by one of the walls of the main building. One of these is the machine of H. D. Stratton & Co., of Columbus, Ga. The machine has a capacity of 5 tons per 24 hours, and is said by the exhibitor to produce ice 14×14 inches square and 33 inches in length (representing a block weighing 200 pounds). In connection with this machine are two storage rooms, 12×12×9 feet, for preserving meat, fruit, etc. The machine depends, as do all the machines of its class, upon the absorption of heat in the conversion of liquid to gaseous ammonia, and the removal of this heat by outside cooling. The heat is thus extracted from a large tank of salt water, which acts as a reservoir of "cold!" The cans containing the water out of which it is intended to make the ice, are plunged into this tank and their contents, when frozen, come directly to market. So far the Stratton Co. only bases its claim to more patronage than its neighbors on the grounds of "simplicity, economy of fuel, durability, accessibility" (of the several parts of the apparatus), and no one need be astonished if these claims lose nothing of their real merit from modesty in being put; but what must be supposed to be Stratton & Co.'s estimate of the intelligence of the public attending the "World's Centennial and Cotton Exposition," when it proceeds to claim, under the caption of "The quality of ice produced . . . and the next valuable point is the *durability* of the ice produced. We freeze ice at a temperature of about 5 degrees Fahrenheit—that is, the ice is cooled 27 degrees below the freezing point, which ice *contains fully 20 per cent. more cooling capacity than ice at 32 degrees;* and being so thick, namely 14 inches square, it will *last much longer* than the best Northern ice." Doubtless there may be some persons who will visit the New Orleans fair who will be taken in by this statement as certain persons were,

some years ago, by the reported discovery in Mount McClellan of a mass of "permanent ice," which was so powerfully cold that a small piece of it could be used to cool large quantities of water without perceptible diminution of its substance or increase of its own temperature. Such persons will, however, be rarer than means of conveyance, here if such an hyperbolical comparison may be allowed.

Several forms of fire-escape were exhibited, none of which were remarkable for their apparent applicability, simplicity or cheapness; but an experiment with one of them in the Exposition added two transient patients to the hospital, and very nearly added to the occupants of the above-ground mortuary temples of the Crescent City. One with which no accident occurred, was sent by Seagrave & Fuller, of Worcester, Mass. It consists of a boatswain's chair on a pulley, the latter being easily controlled by a spring catch, etc.; but the question of how to get down from a third-story window when the second story is in flames, and one has not this very comfortable apparatus already rigged, seems as far from solution by this invention as ever.

One of the labor-saving machines contributed by New Orleans itself was the "wonderful combination self-heating iron," of Mrs. Fox. This was exhibited by its gifted inventor near pillar D-46. It consists of a hollow case shaped like a flat-iron, which is capable of rotation around the handle. A gas tube is attached to the axis which forms part of the handle, which latter is perforated to allow a number of small jets of flame to burn in the hollow body of the iron; so that while one surface is being used, another is being heated for future use. Mrs. Fox believes that ironing thus becomes a pleasant pastime. (We are somewhat incredulous about this.)

There are several type-writers exhibited near each other which introduce new features into the art. All of them are from New York and its vicinity. One is the "Columbia Type-writer," (office at 320 Broadway, New York city). This is a convenient little apparatus which has the advantages of lightness, cheapness, and adaptability to various purposes, but not speed and ease in writing. It costs complete, $25. Another form costs the same as the Remington, but can employ different fonts of type, which can be changed at short notice, and has a larger number of characters, which are operated by a piano key-board. On the other hand, the paper must roll up in an enclosed cylinder, and, the movement of the type being in a horizontal plane, no alterations of alignment to suit specific purposes is possible.

The American wines are fairly represented, including the Jarvis Brandy Co., of California, and the Cook St. Louis champagnes.

Henry Bornstein, of 7 Lancaster st., Boston, has not hesitated to bring to the notice of the international public his patent pin hooks for tidies and pillow-shams.

Germany is represented by one of the countless "genuine Farina Cologne" collections, which have by this time been tolerably well impressed upon the attention of the world.

The Meriden Britannia Co., of Meriden, Conn., has a fair display of its electro-gold- and silver-plate. This is so familiar to the public that it needs no "bush."

Jesse Marden, of 55 S. St. Charles st., Baltimore, has a very good exhibit of scales and balances for all sorts of purposes, and sets of metric weights of convenient form for handling.

The Chalmette Mills exhibit, near TT-12, a cotton bale and the product of their manufacture in sheeting. Close by (TT-7), an excellent collection of specimen ornaments, figures and columns is shown by Bakewell & Miller.

At one extremity of the Mexican exhibit, but forming no part of it, is a somewhat uneven exhibit of Mexican goods by a Mr. Peters (an American), who has brought the articles through the United States Custom House, and has them for sale. Many of these goods have been chosen with excellent judgment and are not dear compared to other things in the Louisiana metropolis. The feather pictures are very pretty, and indeed show a delicate appreciation of the requirements of true art on the part of the Mexicans by whom they were made.

Cooper, Hewitt & Co., near pillar E-15, show a small collection of articles, many of which were old friends first seen in the Centennial, NOT of cotton. In addition, there is a specimen of "corrugated strip iron for fences." This firm has the contract for the iron work of the projected Brooklyn Elevated Railway, and is turning it out at the rate of 60 tons per day.

The Pratt & Whitney machine gun is an interesting addition to warfare. It fires 500 shots a minute from two stationary rifled steel barrels in a water jacket, which prevents undue heating.

At E-28, the Thomson-Houston Electric Light Co. makes a very good display of its light. Close by is an Edison Pavilion which pre-

sents samples of all the kinds of electrical apparatus which that electrical genius has invented.

The machinery of the main building and that portion which has the distinctive appellation of Machinery Hall, is driven by two engines located nearly in the centre of the large building. Each engine keeps in motion the shafting on one side of the building. One of these is a Reynolds-Corliss engine, and the other a Harris-Corliss, of Providence, R. I. A 28-inch Gandy patent belt keeps the shafting in uniform motion with the large fly wheels. The power is transmitted regularly and easily but not so noiselessly as was the case with the monster Corliss of the Exhibition of 1876.

A very handsome display is made by the Northwestern Terra Cotta Works of True, Brinkhorst & Co., of Chicago. This included tablets, pillars, bas-reliefs, etc., all of which showed good workmanship and design. Near UU-37, the Monument Bronze Co., of Bridgeport, Conn., has a good exhibit of "white bronze" monuments in every way creditable to it.

The Birdsall Portable Saw-mill, at MM-59, illustrates an admirable adjustment of the necessities of this kind of industry to the needs of the ever-moving lumbermen. In this connection, too, should be mentioned the excellent adjustment to variable feed and perfect and easy control of the circular saw-mill of Liddell & Co., of Charlotte, N. C. and New Orleans, La. There is not space here to describe the mechanism, but it may be said that by the slightest movement of a lever the velocity of the feed is controlled or reversed, according to the will of the engineer.

The McCormick Reaper and Twine Binder holds the place which it has always held in spite of the active competition of both American and foreign inventors. It will be remembered by many interested in this branch of industry what a surprise was given to the Americans during the Centennial Exposition by the exhibit of the Russian agricultural machinery. But the old McCormick Reaper and Binder has never yet been surpassed, and it is somewhat questionable if, for the purposes to which it is adapted, it ever will be. (II-56.)

Not far from the reaper is the Curtis Improved Factory Churn, which, if it does not astound us with any novelty of principle, serves to remind the casual observer to what enormous proportions the dairy industries of the United States have grown.

The wagon building, mentioned in the early part of this sketch,

contains fine specimens of the wagon-builder's art from all over the United States, but nothing especially novel. Indeed the remark made elsewhere about meeting old friends of the show of 1876, applies perhaps more than in the main building. This tendency to build one or more sample objects for the needs of a great fair, and to keep them for use at future fairs, held even ten years afterwards, is not calculated to give the visitor confidence in the representative character of the said samples, nor in the enterprise of the exhibitors. Amongst the gimcracks included in this department is a patent gate so arranged that by pulling a suspended wooden bar the gate rises and shoots into a slot made for it in the post. It is called the "Stong Excelsior Farm Gate," and one of its recommendations is that when the snow lies deep it still will operate. The suggestion of the application of this invention in New Orleans, where the temperature was about 80 degrees, had its humorous side.

Michigan cider was well illustrated at FF-20, where a somewhat enthusiastic person descanted on its merits as a beverage as if there were no such thing as cholera.

The Louisiana silk-spinning exhibit at FF-15, was, or rather would have been interesting, had the manipulation not been subject to frequent interruptions. Nevertheless the heating of the cocoons in boiling water, and the reeling on spools of the rich golden silk were very interesting details to those who had not seen the *modus operandi* previously.

The French section is found near (R-20-24), but it is not at all a fair sample of what that great centre of taste and culture ought to display. A few vases and bronzes such as are found in any jewelry establishment of any city of twenty thousand inhabitants, a few "articles de Paris" are all that attest that "la belle France" is the exhibitor.

The Austrian exhibit is not very different. There are some quite comfortable looking bent-wood chairs and stools, and apparently numerous orders for them; but any such variety of objects and industries as should characterize one of the "Great Powers" is looked for in vain.

The galleries of the main building are very spacious, but seem to be but little visited. Many of the exhibitors there alluded to this fact and complained of it. Several of the exhibits there are among the best and most characteristic of the entire show.

At V-16 is a display of stained glass which is not very remarkable. At V-18 Mrs. L. E. Beard, of Detroit, exhibits a species of artificial

paper flowers which she has devised, and which are extremely pretty, but not the sort of thing for which most people go to a world's fair.

The Leedom carpet works make a creditable showing for Philadelphia on the same gallery, and not far from the last-mentioned exhibit. Hubbard's hammock chairs, well known in the summer resorts of the luxurious, are also at no great distance, but all the exhibitors in this part of the building appear to be suffering a banishment like Arabi Bey, and eagerly scan the features of any new comer, whose footsteps are heard echoing down the broad wooden way. This interest, while it may be mistaken for flattery becomes embarrassing when the stranger is a modest man, and cannot easily tear himself away. The furniture exhibit of Tisch at NN-2, is fair without being of a character to delay the visitor very long.

At D-2 is a collection of medical furniture among which are articles which remind one of the nameless curiosities of Hotel Cluny, in Paris. For instance, Dr. Wilson's "Gynœcological chair," if it had been known to the Spanish statesman in the palmy days of the Inquisition, would have been turned to excellent account in some of the ceremonies which delighted the people of that epoch.

Following Dr. Wilson are many kinds of carriages and furniture along the broad passage until one arrives at the "Daisy automatic light swing maker for children" (FF-62). But without doubt a really unique, as well as the finest exhibit in the galleries is that of Mr. N. Friederich, of San Antonio, Texas, who has for some years enjoyed a national reputation for his beautiful cattle horn furniture. After comparing Mr. Friederich's work with the best European manufacture of like objects, it must be said to Mr. Friederich's credit, that nowhere can one find these expensive luxuries finished with a more conscientious regard to their durability, and with more good taste, than in his specimens. The horns which he weaves together to form the backs and arms of his chairs, are all first carefully cleaned inside and filled with plaster of Paris in their narrow and tortuous parts, while the straighter and larger parts are filled with pieces of wood carefully cut to fit them. Thus if one of these handsomely prepared horns falls on the floor it is not injured. Chicago, at UU-58, presents a bar counter and sideboard under the title of "standard saloon fixtures," which confirms the often expressed view that she is the champion of the world in all that concerns this sort of public conviviality.

It seems almost unavoidable to express surprise that many obvious

lessons as to the means of providing for the health and comfort of the public which might have been learned at the Philadelphia Centennial or any other of the great world's fairs, appear to have been entirely unlearned; and the management of this one seems to have approached the problem as if there were no experience to guide one, and that all the facts had to be established for the first time by the experience of the New Orleans management. This has been a great and costly error, and moreover it has prejudiced the success of the fair from the start.

The S. S. White Dental Mfg. Co. of Philadelphia, makes certain articles for the whole world, has exceeded all its previous efforts in the display of novelties by an act which cannot but be regretted. In the last decade or more of political corruption we have not been surprised to hear mutterings from the public men who felt their own insignificance beside the greatest of patriots and soldiers. We have seen it slyly inserted into the newspaper paragraph that Washington was sharp at a horse trade; that he would occasionally indulge in profanity; that he was a sham in fact, and only presented his fair side to the world, etc. We have always indignantly repudiated this idea, and demanded an instance of his hypocrisy. Now, the S. S. White Co. comes to this World's fair with a set of false teeth, each one of which was carved out separately from a piece of ivory, and tells the world that this is the machinery that the great George employed to masticate his elegant Mount Vernon dinners. Such conduct merits that the rest of the exhibit of this firm (which is really very fine) should be passed over in silence.

One more Chicago exhibit should be alluded to since it is characteristic of the enterprise, dash and appreciation of the value of time of that great metropolis. Herr N. Neufeld of 25 Randolph street (that city) paints oil pictures for the public "while you wait." It is said by some of his fellow-citizens that his talent is really as great as that of Meissonnier, but that it requires a brainy, progressive place like Chicago to do it justice. While the crowd waits, a canvas grows from gray to white, and from white to blue; and rapidly the natural tints of a landscape by moonlight or sunlight start out as in the stereopticon, and a new symphony is born. Price $1 to $1.50, according to size.

THE UNITED STATES BUILDING.

This is a building much smaller than the main building and dedicated to the exhibits of the United States and the several States. Here may be seen a healthy rivalry among the latter and the results of

the experience, taste and leisure of the officials of the Government Departments at Washington. Of course the Smithsonian cannot fail to outshine the other branches and twigs of officialdom in a line so completely its own; and accordingly one sees a fair proportion of its collections well labeled, arranged and displayed. Among the objects most generally interesting to the public are its display of casts, breeding apparatus, etc., of the food fishes.

Most of the Executive Departments of the Government (if not all) are represented with some approach to regardlessness, but not always (it must be confessed) with good taste. For instance, the Interior Department leads the van of the teratological procession by a display of a monster latticed Easter egg designed (so far as the average visitor can see) solely to illustrate how much money can be spent without any apparent purpose. This thing looks like a patched-up ostrich egg, with views of Swiss scenery or geography painted over it at a Kindergarten. Its form is a prolate ellipsoid and its longer diameter is vertical. Perhaps it is the globe amended by the Interior Department, (a notable improvement on Nature.)

If the Interior Department has won the prize for the solution of the problem of how to put money where it will do the least good, the Post Office Department is not far behind it with an object lesson-panorama resembling those which adorn the outside tent walls of the parasitic side shows of Barnum's Museum. This extraordinary production stretches around three sides of a square at a distance of some ten feet above the heads of the visitors, and represents: 1. A row of dwelling houses. 2. A few factories. 3. A double-decked bridge supposed by the public to be either the Eads bridge, the Brooklyn bridge, the Pons Assinorum, or perhaps a Venetian structure (as it is evidently a bridge of size). A stage coach, a train of cars, a pony and rider, and various other things either are about to cross, are crossing, or just have crossed the structure, which shows that it was not put up by contract of the Post Office Department. Opposite to the dwelling houses and factories and on the other side of the river are plains, bad lands, mountains, valleys, and all the things that may be supposed to arise on the night-mare imagination of the Ring, after a Star Route dinner. Talking of that, a very neat and appropriate idea of the Post Office Department is the exhibition of the officials of the various Post Offices grouped together in *star-shaped* frames, with the Postmaster of the place in the

middle, and his genial staff occupying the points of the star. This idea deserves to be perpetuated in the seal of the Department.

The Navy Department has to a large extent the same objects which were shown at the International Electrical Exhibit, including the same jolly Jack Tar to explain them. His cold-blooded indifference to peril, while explaining the action of the terrible torpedoes, to nurses and children, fairly makes the flesh creep.

The Greely Relief Expedition is displayed not far off, presumably by the War Department. The figures consists of suits of furs occupying very exactly the attitudes given by Thomas Nast to his pictures of the rag baby, but into the hood of each suit has been thrust a hair dresser's dummy (usually nearly right side up) making the entire figure look like a new thing in "grab bags," or a Laplander's Christmas stocking. They are beautiful, and a great deal more artistic than most straight jackets.

The various States seem to have vied with each other in presenting their several exhibits in a manner agreeable to the eye.

Pennsylvania cannot, however, be justly included in this statement; for although it may be true that the gentlemen who have endeavored to secure a collection of her products, and a general resumé of her industries, have not been sufficiently supported by the State Government or the people; the fact is nevertheless patent that the exhibit in her enclosure is chiefly notable for what it does not contain. The State displays are contained in areas either railed around on the open floor, or ranged around the walls with partitions to separate them from each other. Pennsylvania belongs to this latter class. The first and most prominent object to rivet the attention on entering the miniature domain of the Keystone State is a very large, life-size oil painting of Zachary Taylor. No doubt the commissioners had some reason for putting this picture there, but unfortunately the gentleman in charge of the enclosure at the time of my visit could not inform me of it. He said, however, that the painting was valued at $10,000 at that time. What it may be worth now, is somewhat difficult to say owing to the fact that the lower part of the painting seemed to be exposed to the direct rays of the semi-tropical sun of that latitude for the greater part of the day. Large photographs of several of the officials of the State Government, the Philadelphia Government, etc., occupy a proportionately larger amount of the space of the State than any other industry. But here, too, the classification is not quite fair; inas-

much as the arrangement robs Scotland of part of the glory that belongs to her, by placing Mayor Smith among the Pennsylvanians. Governor Pattison, Simon Cameron, General Hartranft and Senator Wallace are comprised in this family album, and the superficial observer would imagine that this was the most valuable as well as the only unique kind of production that the State could show; much more so for instance, than the petroleum trade, which is presented to the world in a couple of long thin bottles containing liquids of various shades of brown. The Alabamian, or Louisianian who, misled by the glowing account of the superiority of the resources of the former State to those of Pennsylvania, which a distinguished Philadelphia editor has recently given, and wishing to learn something of an industry that was forgotten when those flowing periods were written; would be obliged to assume that the oil was obtained from brooks or rivers, or from the rain cistern, so far as the exhibit professing to illustrate this activity instructs him. The iron works of the State are easily accomodated on a table space which would be deemed insufficient for his daily needs by many a country lawyer. The volumes of the "Second Geological Survey of Pennsylvania" were indeed found arranged in a dusty row on an out-of-the-way stand, but there was no large map such as many of the other States prepared, to give the non-Pennsylvanian an idea of the relative positions of the various mineral fields of the State. The The day of one visit to this shrine was said to be "Pennsylvania day" but no one was observed about the place whether visitor or attendant. (It ought in fairness to be said that this refers to the *evening* about 4.30 P. M.)

Ohio makes a very fair show.

California is seen from afar by means of an American flag of nearly twelve by six feet made of pampas plumes. Sonoma County also has a very handsome semi-circle of pampas plumes twenty by ten feet.

Arizona may be given credit for a very good display of copper and silver minerals, and for her cactuses from Cactus County. Among the pleasing photographic representations of her wealth of resources, a prominent one is a photograph representing a gentleman hanging by the neck from a telegraph pole, surrounded by a very respectable crowd of citizens, most of whom have put on a holiday expression as if the photographer had just said "Now look as pleasant as you can." The incident took place (so says the legend underneath) on March 28, 1884.

A mineral collection from Cochise County; cotton from Maricopa

County. Potatoes with "no irrigation," copper, lead and silver ores from the Hackberry district, with a handsomely arranged cabinet of minerals belonging to Professor Wore, of Tucson, complete a display which is deserving of attention and redounds to the credit of the enterprising citizens of the State.

Colorado also has put forward not only a valuable sample of her chief (mining) industries, but also a collection of woods and grasses which form a centre of attraction.

Oregon, Idaho and Montana are well represented.

Kansas, Dakota and Nebraska are all decorated with artistically arranged grasses and contain much of interest. The second of those just named has a large grass plot on which are set up a number of stuffed animals as samples of her game.

Minnesota leans toward realism in a display of unconventional Indian figures and a thin artificial waterfall labeled Minne-ha-ha.

South Carolina shows a fine collection of woods, etc., and an immense pyramid composed of her phosphate deposits.

North Carolina comes to the front with a beautiful grass display in addition to those products which are more usually associated with her soil, such as turpentine and lumber and dipping-sticks. Her cotton exhibit is also good.

Virginia spreads before the gaze of the beholder the regulation "Natural Bridge," over which the Father of his Country is said to have thrown a stone, and without an illustration of which any geography of the State would be incomplete. This time it is a paste-board and canvas picture of the great curiosity upon which, in truth be it said, the artist cannot be congratulated. While this takes up more room than anything else, let it not be supposed that there is nothing else in the Virginia department. The rest of her exhibit is fairly good, if not what one would expect from the Mother of Presidents.

New Jersey displays prominently a wooden soldier with a placard to inform us that of such is the material that took the first prize for discipline and soldierly bearing at the inter-State review at Yorktown. The silver vase commemorative of this achievement is on exhibition alongside of the soldier, and serves to point the moral that if New Jersey cannot produce silver herself; she can at least secure what others have produced. Besides soldiers, we learn by the objects that New Jersey produces magnetite, terra-cotta, fish, glass and wine; just as we

learn that Pennsylvania in addition to statesmen, produces "Stratena" which will hold them together in spite of a centrifugal tendency.

The habit of granting to a railway company the space for an exhibit of the products of the region which it drains; a tendency carried to excess in the New Orleans Exhibition, cannot be too emphatically condemned. First, it destroys all classification of the various objects by associating a geographical division (by States etc.), with a purely accidental assemblage of things from different regions selected because the commercial necessities of a railway have caused it to pass over a certain number of States in a certain order. Second, these displays being merely advertisements of the railways, their excellence is more dependent upon the wealth of the companies making them, than of the regions passed over. One of the least of the objections to such displays is that the same region is made to do duty several times for different railways and for the States in which they occur.

Louisiana has a fair display of her specialties and also a fine show of artificial flowers. Amongst other things which show both ingenuity and taste is a series of views so drawn that at a short distance they make a word appear. This is done by emphasizing the appropriate lines on a picture in such a way that the general effect of the scene is not interfered with.

It would not be fair to omit mention of the Liberty Bell which was so properly loaned to the New Orleansians. The stalwart members of the police force who were deputed to guard it, doubtless thought that they and it would be a target for continuous pairs of bright eyes in the centre, and amidst the life of the Exposition. In point of fact, their wives and sweethearts (if such there be) may possess their spirits in peace, for the bell and its attendants are stowed away near a lakelet on the grounds where the busy hum of machinery, and the tramping of feet are seldom heard. The rural sight-seers from the neighboring parishes of Louisiana, it is true, often select this spot to rest themselves from the fatigues of walking, and to take their lunch; but its location is usually deserted. The bell looks very imposing on its specially constructed car, and its guardians deserve credit for their vigilance and good nature, but it is not too much to say that scarcely one per cent. of the visitors to the Exposition are aware of its position, if, indeed, they are of its existence.

Another object in the grounds not heretofore mentioned, is the standpipe which on occasions pours a liberal supply of water over its top

and produces a much needed sense of cooling. The art gallery is not mentioned for many reasons here among which is that the sketch is already too long.

It may be said as a kind of supplement, that several of the peculiarities of the City of New Orleans will not escape the notice of even the temporary sojourner when his attention is divided between its ordinary attractions and this show. The facts that all the drainage is through deep gutters on the surface, and that all the "vaults" are structures of marble or other stone for the reception of the dead, built on the surface of the ground, will occur to him as important factors in the prevalence of yellow fever. The streets of the city are indescribably filthy, and malodorous, and the levees near its busy parts reeking with offal. The cistern water, which is used for drinking purposes, is (frequently) as discolored as the Mississippi itself, and can hardly fail to be an active agent of poison in the sickly season. The buildings are, many of them, very large and stately, and the appearance of the city viewed from the summit of the Cotton Exchange is one to impress one with its commercial importance. But many of the houses are unaccountably damp, and in reality almost every stranger during the last month or two has been promptly attacked by an influenza and fever. Some of the customs of the city are peculiar. For example, during the time which has been alluded to in the foregoing notes, there died a M. Armand Pitot, and notices of his death were observed attached to the telegraph poles, and some public buildings throughout the city. It is true that he appears to have been a man of unusual influence and popularity, but this manner of distributing a "faire part" would have been thought strange in France itself. The lake is the great resource of the tired and heated inhabitants during the summer, but it is even in early spring, itself too hot to offer any but a comparative relief. How hot must they be who are relieved by a trip to its shores in summer!

During the Exposition the superb band of sixty odd musicians of the Mexican army played alternately in the main building and at the lake; of which the two resorts, situated about three miles from each other, are Spanish Fort and East Side Park. The former of these was the scene of the concerts. It is strange, but true, that Wagner's music was rendered with an intelligence and expression worthy of Thomas himself.

The squadron of United States vessels lying in the harbor offered

almost as much of interest to the visitors as the fair, if one may judge from the crowding of the boats which took off the public to the ships. The naval vessels are better supplied with water than any resident in or near the city, for they use condensed water, not only for drinking purposes, but even for washing the decks.

It was the writer's good fortune to be present at one of the grand drawings of the L. S. L. (or Louisiana State Lottery), The drawing took place in a little theatre near the St. Charles Hotel during the morning hours (and perhaps for a part of the afternoon). Nothing could be fairer than the drawing of numbers from the huge glass drums, and if the calling of the numbers any unfairness exist it must be practised some time anterior to and taking of the little cylindrical boxes which contain them out of the "wheels." The scene was a peculiar one. To the right and left of the stage respectively sat Generals Beauregard and Early. The former a decidedly fine looking and quite Creole-like old gentleman, with white flowing moustache and unmistakably French features. As I looked at him with half closed eyes I thought myself back again to that period twenty-four years ago when the whole people were frenzied at the news from Charleston, the firing on Fort Sumter, and the assumption of active hostilities by General P. G. T. Beauregard who never gave the readers of his proclamations the grace of an omission of one of all his alphabetical fore-names. Then I remembered so well a certain calm evening about February 1, 1863, when a fleet of ten or twelve vessels were lazily rolling in the at-all-times heavy sea-way outside of Charleston Harbor, and while the flag-ship "Powhatan," Commodore Gordon, was in the act of performing its military Angelus, that a small speck was seen coming out from the direction of the city. The Quartermasters soon made her out to be the Rebel Ram "Chicora," accompanied by another craft, and the Commodore without even stopping the music or depending on the other vessels of his fleet, quietly slipped his anchor and went directly towards the approaching enemy with a full head of steam. But the flag-ship had not moved far when it became apparent that the others were retiring. A few minutes more and this was patent to the naked eye, and thus would have ended an incident akin to that of the alleged King of France and his men, had it not been for the imagination of a Beauregard. For, what was the surprise of all the officers and men of the fleet to see a few days afterwards in a Rebel paper the proclamation of the great proclaimer stating that the two vessels

aforementioned had run out to sea five miles beyond the usual anchorage of the fleet without having seen a Yankee gunboat. And here was the old gentleman himself sitting before us neatly attired, his body erect, his feet slightly spread apart, and his hands receiving the little boxes from the hand of a lesser than he, opening them, taking out the little slip which each contained, and reading the number thereon inscribed, which he repeated in a low but distinct voice to an attendant who repeated it aloud in the manner of a soothsayer announcing to Cæsar the fate of the Roman legions. The solemnity of this utterance of itself would have dispelled any lingering doubt as to the entire good faith of the whole performance. On the other side sat the small and somewhat bent form of General Early; adorned with a great flowing white beard. But his eyes were sparkling and penetrating, and one recalled many things of him of quite another kind. For instance, there are Philadelphians who were either regular or temporary members of the first Troop of City Cavalry during the emergency campaign of June and July, 1863, (and among them our then Cornet the Hon. Samuel J. Randall), who will recall towards the end of June of that year a certain march made with extraordinary expedition due to an earnest desire on the part of all not to incommode the march of White's Brigade of Cavalry which formed part of Early's Corps. Here was the old Confederate warrior in the flesh, whose bare name caused the lamented Samuel Small, then Chief Burgess of the town of York, to ride miles into the country in order to deliver up the "keys" of the town; and looking just as full of life as ever, in spite of being somewhat bent by his advanced age.

FLUID CIRCULATION OF THE SUN'S MASS.—Father Lamey assumes the fluidity of the solar mass as a fundamental postulate and endeavors to show that in consequence of the continual cooling of the superficial layer the entire mass must be kept in constant circulation. The result may be represented by a very simple geometric curve having many points of tangency with the surface of the solar globe. He considers that this curve furnishes a satisfactory explanation of the general distribution of sun spots, their double movement in latitude, the eleven years' period of solar activity, the variation of the movements of the spots in latitude, the conservation of solar energy, the inequality in the periods of increase and decrease of superficial activity, the periodical oscillation of the chief zone of sun spots, the inequality in the activity of the two hemispheres, the variations in the velocity of rotation, the inclination of the hydrogen protuberances and the characteristic configuration of the corona.—*Comptes Rendus*, May 6, 1884.

C.

A SIMPLE FORM OF DRAUGHT GAUGE.

By Professor J. Burkitt Webb, of Cornell University.

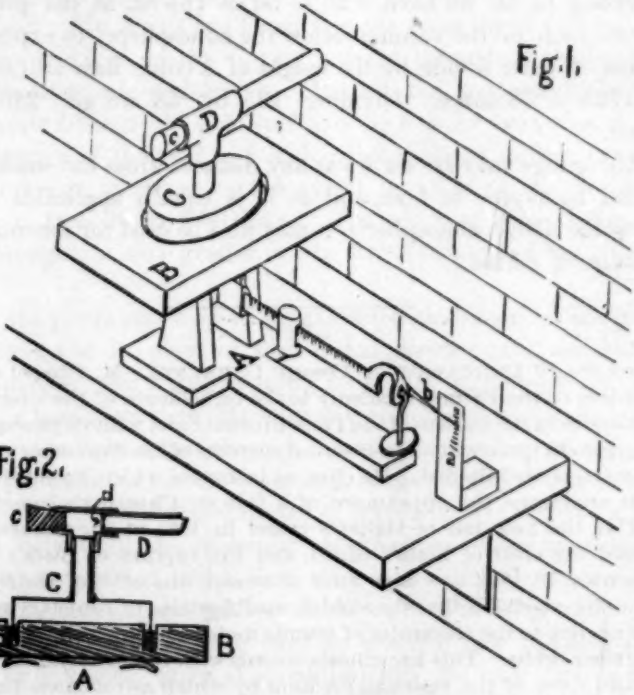
During the Electrical Exhibition I had the pleasure of devising, and by request now describe, a simple instrument for measuring the vacuum in a flue directly by means of scales, and without using a column of a liquid or a spring. It was used simultaneously with other instruments for the same purpose and gave good results; it is to be recommended for the directness and certainty with which the results are obtained, and the absence of any necessity of standardizing it to get at the true value of its readings.

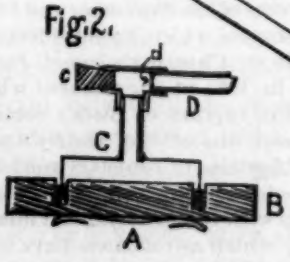
Any form of scales may be used, weighing, preferably, to fractions of an ounce. Upon the scale pan, *A*, (see Figs. 1 and 2) is placed a board, *B*, in which there is an annular groove filled with mercury; this and the scales are the only moving parts of the apparatus. The rest consists of the lid, *C*, whose edge dips into the mercury in the groove, and the pipe, *D*, which connects this lid with the interior of the flue or stack, so that the same vacuum exists beneath *C* as in the stack. This pipe also serves to support the cover while the mercury joint allows the board to rise and fall with the scales. It is evident, therefore, that the atmosphere will press upon the board everywhere except beneath the cover, where there will be a less pressure, so that if the scales have been balanced for the weight of the board and mercury they will be drawn upward by the suction of the vacuum under the cover. The amount of this is clearly equal to the area beneath *C* multiplied by the number of pounds per square inch difference between the vacuum and the atmospheric pressure, and can be obtained directly from the scales and the difference of pressure calculated.

In the pipe, *D*, there is a diaphragm, *d*, through which there is a small hole; this prevents rapid fluctuations from disturbing the balance, while it allows the same average vacuum beneath *C* as in the stack, there being no leakage past the mercury joint. It serves a further purpose, also, in connection with the plug *c*; by withdrawing this plug the atmosphere has access beneath *C*, so that the scales can be balanced at any time without the vacuum in the flue affecting them. The edge or rim of *C* should be thin, and not soluble in mercury; it can be made of sheet-iron riveted and the joint made air-tight by varnish. The area of *C* can be calculated from measurements of its diameter, or by

impressing its edge upon any soft surface it can be obtained with a planimeter.

The mercury should be pure enough not to clog the motion, and its buoyant effect upon the cover, whose edge will necessarily be of some thickness, can be utilized to make the scales weigh to small fractions of an ounce, provided only that the knife edges be in good order. To accomplish this, a pointer, *b*, is fastened to the scale-beam so that it will play over a roughly-graduated arc upon the card, *a*, and indicate the exact position of the beam; to find the value of the divisions in parts of an ounce, remove *c* and note how many divisions the pointer moves over when the pee is moved a quarter or half ounce; the thicker the rim of *C* the greater will, of course, be the value of each division. This pointer and scale also allows small changes in the vacuum to be noted without moving the pee.





A modification of the apparatus, which dispenses with the use of mercury, consists in using a shallow metal cylinder in place of *B*, and a flat disc in place of *C*, acting as a piston, the latter being a thousandth

or two smaller than the cylinder, so as to move freely in it and yet allow no appreciable amount of air to pass by it. In this form of instrument the diaphragm, *d*, must be replaced by a cock, which can be shut to balance the scales, and has when open sufficient passage-way to prevent what little air passes the piston from affecting the vacuum under it to any appreciable extent. The piston must also be hung from *D* by a rubber tube so that it can hang freely in, and without pressing against, the cylinder.

Suppose, now, the cover to have an area of 50 square inches, and the scales to read as follows:

With stopper out	28·50 oz.
With stopper in	20·25 oz.
Difference	8·25 oz.

Dividing by 50 we have $8{\cdot}25 \div 50 = {\cdot}165$ oz. as the pressure per square inch of the vacuum below the atmosphere; to express this in inches of water divide by the weight of a cubic inch = 1,000 ounces $\div 1728 = {\cdot}58$ ounce. Dividing ·165 by ·58 we get ·286 inches of water.

The gauge may be set up at any distance from the stack and connected by a pipe or hose, and as it is equally applicable for slight pressures above atmospheric, it may also be used for determining the pressure of a blast.

COMETARY INDICATION OF COSMIC CURRENTS.—M. Chapel called the attention of the French Academy to the coincidence of the singular transformations in the nucleus of the Pons-Brooks comet with its passage through the region in space where the cosmical currents of the November and December meteors are mingled. He cites, as instances which he considers somewhat analogous, the appearance of a tuft on Cheseaux's comet, January 25, 1744, the new tail of Halley's comet in 1835, at the moment when it crossed the orbit of Biela's comet, and the rupture of Biela's comet on December 19, 1845, two days after it crossed the orbit of Halley's comet. Hence he concludes that the sudden modifications of cometary nuclei and tails are due to the encounter of cosmic materials which the comets scatter over their orbits. This hypothesis accords with the most rational idea that we can form of the resisting medium by which astronomers have sought to account for the acceleration of Encke's and other comets. It may, perhaps, aid us in sounding the planetary spaces and discovering the presence and mode of distribution of cosmic matter.—*Comptes Rendus*, March 3, 1884. C.

On the ELECTRO MOTIVE ACTION of ILLUMINATED SELENIUM, DISCOVERED by MR. FRITTS, of NEW YORK.

By Dr. Werner Siemens.

Read before the Berlin Academy of Sciences, February 12, 1885.

Mr. Charles E. Fritts, of New York, sent me, early last year, a description of his method in relation to light-sensitive selenium plates, differing from mine in essential features, and accompanied the same by a number of the plates prepared by him. These do not, like mine,* consist of parallel platinum wires embedded in a thin body of selenium, but of a thin homogeneous sheet of selenium, which is spread upon a metal plate and, after a subsequent heating—for the conversion of the amorphous into crystalline selenium,—is covered over with a fine gold leaf. Mr. Fritts has found that the green light penetrating through the gold leaf, by the further passage through the selenium, increases its electrical conductivity. In fact, the conductivity of the selenium plate between the gold leaf and the metallic base-plate is, by the illumination of the gold leaf with direct sunlight falling perpendicularly upon it, increased to the extent, in some of the specimens sent over, of from 20 to 200 times! The effect of illumination by diffused daylight is also greater in Mr. Fritts's constructions than in mine.

One of the plates sent over to me exhibited absolutely no sensitiveness to light, but in place of that it has another most remarkable property, namely, that a galvanometer connected up between the gold leaf and the base-plate shows the existence of an electric current in the direction of the light-action through the selenium, as long as the gold leaf is illuminated. I, in the beginning, conjectured that this current was not lasting, but had the character of a polarization current, which continued only until the molecular modification of the selenium by the light was completed, and a first trial seemed to corroborate this idea. But further experiments convinced me that this supposition was erroneous. In reality, we have here an entirely new physical phenomenon to deal with, which is scientifically of the most far-reaching importance (" *die von grösster wissenschaftlicher Tragweite ist!*")

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* *Monatsbericht der Berl. Akad. d. W. vom* 13 *Mai*, 1875, *und* 7 *Juni*, 1877.

My experiments have shown that, by the illumination of the gold leaf, a difference of potential is established between it and the base-plate, which is, to all appearance, proportional to the intensity of the light, and which stands forth unchanged so long as the illumination remains constant. Obscure heat radiations do not produce electro-motive force, and therefore the supposition of a thermo-electric action, as the explanation of the phenomenon, is excluded. Mr. Fritts holds that the light waves penetrating into the selenium are transformed directly into electrical current, and therefrom states the fact that the strength of the current is proportional to the strength of the light. They showed themselves to be approximately so, by the collated experiments in the following table:

Strength of the light in standard candles..	6·4	9·9	12·8	16·8
Strength of the current.....	18°	30°	40°	48°
Quotient.....	2·8	3°	3·1	2·8

The strength of the light was measured with a Bunsen's photometer, that of the current by the deflections of a sensitive mirror-galvanometer.

With the gold leaf exposed to the light from the southeastern portion of a cloudless sky, while the sun itself was hidden by neighboring high buildings, the series of measurements in the following table were obtained:

Hour of exposure..	9 h. 37 m.	10 h. 5 m.	10 h. 30 m.	11 h.	11 h. 35 m.	12 h.	12 h. 30 m.	1 h.
Deflection of the galvanometer	190	196	209	223	250	250	244	245

Hour of exposure..	1 h. 30 m.	2 h.	2 h. 30 m.	3 h.	3 h. 30 m.	4 h.
Deflection of the galvanometer	249	228	188	173	172	108

It is shown from the foregoing, that the electro motive force of the selenium plate very uniformly increased from 9.30 A. M. until 11.35 A. M., then, the current remained nearly constant during two

hours, and thereafter again quite uniformly decreased until 3 P. M. With regard to the reason why some of his selenium plates become more conductive during illumination, while others generate electromotive force, Mr. Fritts gives no explanation. He speaks of the uncertainty in the preparation of the plates, of whose properties nothing can be foreseen, and gives various manipulations through which unserviceable plates may often be made useful. There is also still needed thorough investigation in order to determine upon what the electro-motive light-action of many selenium plates depends. Nevertheless, the existence already of even a single seleninm plate having the property described is a fact of the greatest scientific significance, since there is here presented to us, for the first time, the direct conversion of the energy of light into electrical energy. ("*eine Thatsache von grösster wissenschaftlicher Bedeutung, da uns hier zum ersten Male die directe Umwandlung der Energie des Lichtes in elektrische Energie entgegentritt.*")

NOTE.—The uncertainties mentioned by Dr. Siemens, as existing at the time I wrote the communication referred to (in February, 1884), have since been largely overcome. I have discovered the conditions upon which the electromotive light-action depends, and, with more perfect means for constructing the plates, I believe that I can even now accomplish the conversion of the greater portion of the energy of light into electrical energy. If my theory of the action proves to be complete, when fully carried out and tested in all of its variations, we may ere long see the photo-electric plate competing, in high efficiency of conversion, with the dynamo-electric machine itself. I have also ascertained the causes of the frequent alterations in the electrical conductivity of selenium plates, and the conditions which will prevent them. I am now able to foresee the general properties of the plates, and indeed to give them such of the properties as I wish. I can cause a plate to show either an electromotive action or a higher conductivity, when exposed to light, or to show both properties. I can cause one surface of a plate to offer a higher resistance to a current than the other does, and can determine beforehand in which direction this action shall be exhibited. I can cause the resistance of a plate to increase and decrease in the same direction as the strength of the current is changed, or inversely; and can change the character of a plate by reversing its action in these respects, and re-reversing it, at pleasure. I have ascertained the *rationale* of the speaking and singing plates described in my paper read before the American Association for the Advancement of Science in September last. Some of the foregoing was known long before the date of my communication to Dr. Siemens, but it is all mentioned here in order to show that the principal points are already pretty well worked out and understood. For obvious reasons I do not yet publish my methods; but many points in the action of selenium do remain, which cannot yet be explained or accounted for.

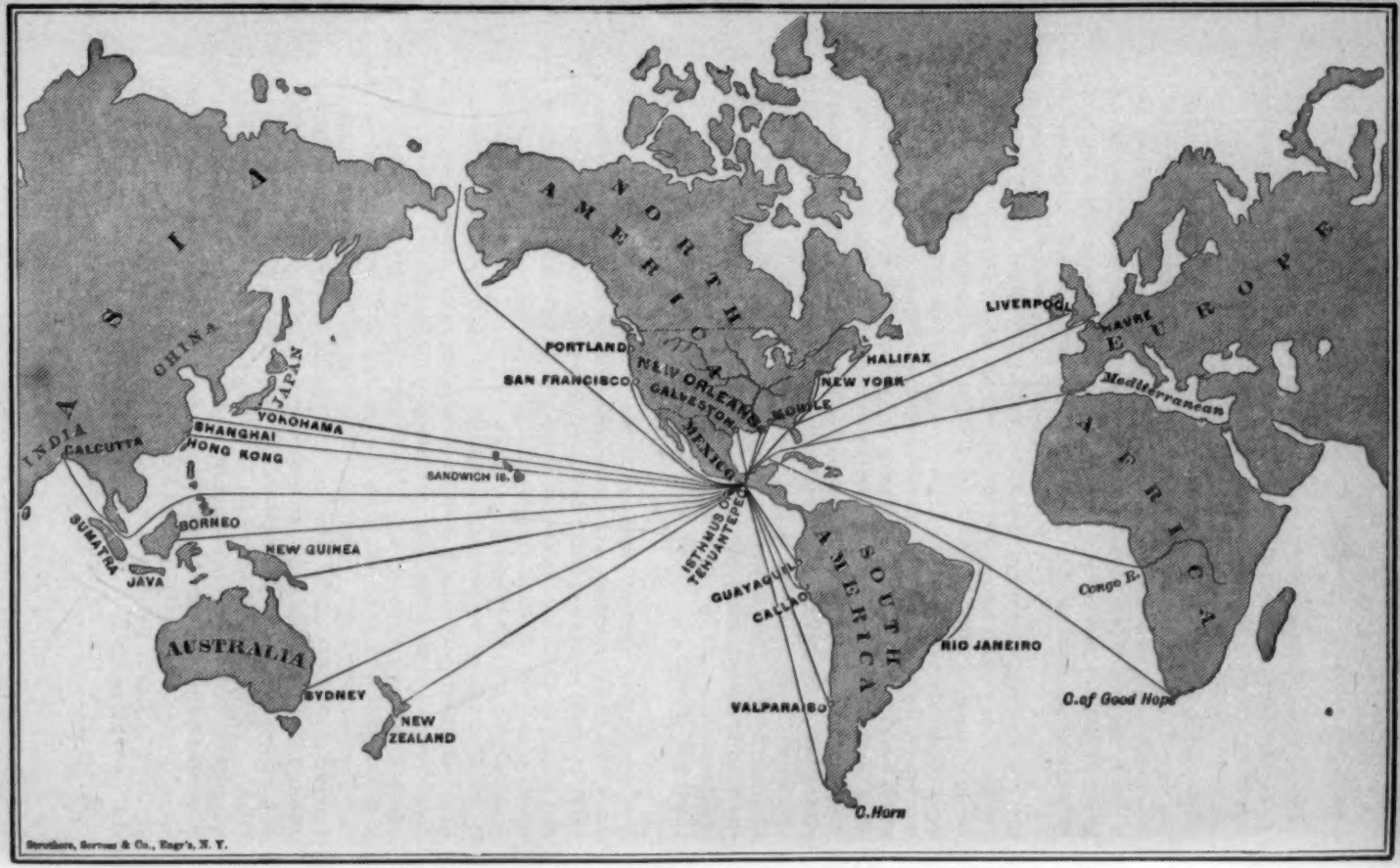
In explanation of the slight irregularity in the action of the electro-motive plate mentioned, it should be stated that it had not been prepared for that purpose, but was sent to him as exhibiting another and entirely different property. During the development of that property, it had received some of the manipulations adapted for giving the electro-motive action, and in consequence thereof it could generate a slight current on exposure to light, although not with the uniformity of a specially prepared electro-motive plate. It should also be noted that "the south-eastern portion of a sky without clouds" (direct sunlight being cut off and excluded) is not a very intense source of illumination. But that fact will only render more satisfactory the proof of the reality of the phenomenon and its nature.

At the time of sending him the samples of my constructions, I had not a very large number of the electro-motive plates, and those were in almost daily use in experiments from which I hoped to deduce the philosophy of the action; so that they could not be spared, and I contented myself with pointing out that this plate could generate a current, sufficient, at least, to demonstrate its possession of that property. After having my papers, data and plates under consideration for nearly a year, Dr. Siemens, than whom there is no higher or better authority, has finally accorded the honor of first discovery to me. Whatever doubts or uncertainties may exist regarding the nature or cause of the phenomena adduced by other investigators, there can be none in this case, since all chemical, polarization and thermo-electric actions are here excluded from consideration, and the phenomenon is here unquestionably the direct conversion of the energy of light into electrical energy.

CH. E. FRITTS.

ELECTRIC CONDUCTIBILITY OF DISTILLED WATER AND GLASS.—G. Foussereau undertook an investigation of the electric resistance of water by Lippmann's general method. He found that specimens from the same laboratory and prepared in the same apparatus, on different days, presented specific resistances, at the temperature of 15°C., ranging between 118,900 and 712,500 ohms. The discrepancies seem to be attributable to substances dissolved from the linings of the vessels, to the solution of atmospheric matter, or to materials dissolved during the distillation. In order to study the first of these influences, he allowed the water to remain in the glass tube which was used for the experiment. For temperatures in the neighborhood of 15°C, there was an almost insensible diminution of resistance at the end of an hour, but reaching $\frac{1}{10}$ of the total value after 24 hours. Above 30°C, the solution of the salts of the glass became very much more rapid. At 75°, the resistance varied so quickly that measurements were almost impossible. Water raised to that temperature and rapidly restored to 15°, had increased its conductibility fourfold. After Foussereau's communication, Chevreul remarked that he had pointed out as early as 1843 the progressive dissolution of the alkalis in glass vessels by the water which is kept in them. For a long time he has employed in his laboratory only vessels of green glass for preserving distilled water or reagents which could be affected by those alkalis.—*Comptes Rendus*, July 15, 1884.

C.



THE INTEROCEANIC SHIP RAILWAY.—TEHUANTEPEC AS THE CENTRE OF THE WORLD'S COMMERCE.

THE TEHUANTEPEC SHIP RAILWAY.*

BY E. L. CORTHELL, Civil Engineer.

Vice-President FRED. GRAFF introduced Mr. Corthell, who spoke as follows:

In the certificate of membership in the Institution of Civil Engineers, of Great Britian, it is stated that the institution is "a society established for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, whereby the great sources of power in nature are converted, adapted and applied for the use and convenience of man."

In other words, the science of engineering is the adaptation of the laws of nature to the wants of man. As engineers, we should take a broad view of the scope of engineering science. The wants of man are varied, numerous and pressing. The laws of nature are given to us to unfold and apply to meet these wants and nothing short of their widest possible application and their greatest possible development is worthy of us or of the age in which we live. These wants are industrial, commercial, mental, social, moral and religious.

This subject, which we discuss to-night, is peculiarly international, affecting all the important conditions that relate to the welfare of the human race. Therefore, our horizon is bounded only by the limits of the abodes of man. From the map before you, and from the statements now to be given, the intimate relations existing between the subject in hand and the peoples of the earth, are manifest. Australia has an area of 2,449,000 square miles; Oceanica, which includes Australasia, Malayasia and Polynesia, has an area of 3,700,000 square miles, and a population of 35,851,000; the United States, without Alaska, has an area of 2,935,000 square miles, and a population of 55,000,000; Japan, with an area of only 169,000 square miles, has a population of 34,338,000; China, with an area of 3,922,000 square miles, has a population of 434,000,000; Hindoostan, with an area of 1,650,000 square miles, has a population of 240,000,000. To fully appreciate and understand the wants of these nations, and of their commerce, an intimate knowledge is requisite of the sources of trade, of supply and demand, of the handling of different varieties of products, of agriculture, manufactures and the mines; of the distance now traversed by the

* An address delivered before the Franklin Institute, December 28, 1884.

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Stephens, Serrell & Co., Engr's, N. Y.

trade of one country with another; of the kind and amount of productions and trade of each country; the reasons for the trade of and with certain countries increasing or decreasing, and many other facts and conditions that affect the commerce of the world.

It would be out of place here to enumerate the great number of details that go to make up the general items of the commercial estimate. A few only are mentioned to familiarize you with the subject. The United States has a feeble commerce with the United States of Colombia on the west coast of South America, carried on either over the Panama Railroad or around Cape Horn. It imports from that country coffee, barks, hides and India rubber, and exports to it iron, steel, machinery, lard, cotton goods, flour, paper, etc. With Peru, it has a trade in soda and guano, and exports to it cereals, machinery, woods and mineral oil. Strange to say, on account of the difficulties in trading at present with this country, many of the articles are shipped from Peru to France on French steamers, and then re-shipped to New York. We have a similar trade with Chili. Our China trade, either across the continent by rail, or by the Panama Railroad, Cape Horn, Cape Good Hope, or Suez Canal, is imports of tea, silk, rice, palm leaf, jute and hemp, and exports of cotton cloth, mineral oil, etc. We have about the same character of trade with Hong Kong and Japan. With Australasia we have the foundations of a diversified trade to be built up when the ship railway is completed. The principal imports from that country to the Atlantic Coasts of the United States are gums, tins, coal and wool. The principal exports are locomotives, machinery, iron manufactures, household furniture, agricultural implements, illuminating oils, barley, carriages, trunks, sewing machines, linen and cotton goods, books, etc. The most important manufactures exported to that country are twenty-seven in number. With the various groups of islands in Polynesia we have a diversified trade. There is, with the Sandwich Islands alone, a commerce of over six million dollars. We receive from them brown sugar, rice and limes, and send them the same general class of goods that go to Australasia. England, France and other European countries, have a nearly similar commerce with the countries mentioned.

It is necessary now to glance at the internal commerce of the United States, because from that we can estimate what its foreign commerce would be, if the barriers now obstructing it were removed, and if the immense surplus products, agricultural, manufacturing and mineral,

could be shipped at a reasonable expense and in a reasonable time, to foreign countries needing our surplus productions. During the year 1883, the railroads of the United States transported over four hundred million tons of freight, valued at over $10,000,000,000. These goods if placed for transportation in one freight train, carrying fifteen tons to the car, would require a train 175,000 miles long, or seven times the circumference of the earth. In addition to this rail transportation there should be added many millions of steamboat and coastwise tonnage, probably equal to fifty per cent. of that transported by rail. While we are carrying, year by year, these immense amounts of freight, the whole foreign commerce of Europe is less than ten billions of dollars in value.

The Mississippi Valley has a commercial internal business, by river and by rail, of over four billions of dollars. Galveston, the seaport of Texas, has a tributary net work of railroads more than six thousand miles in length. The increase of commerce of the countries west of the United States, that is, those bordering on the Pacific, has been one hundred and fifty per cent. in five years; but on account of the impossibility of reaching this business we have less than four per cent. of it—the remainder going to Europe, via the Cape of Good Hope and the Suez Canal.

Our Pacific Coast, California, Oregon and Washington Territories, is especially adapted to the cultivation of cereals, particularly wheat. The salubrity of the climate and the richness of the soil reduce the cost of raising it to a minimum. But on account of the great length of the voyage by which the wheat and the flour of the Pacific Coast reach Liverpool and the other markets of the Old World, it is impossible to compete with the wheat raised in India and Australia. A voyage of sixteen thousand miles, is necessary to place the wheat in the Liverpool market. The cost per ton is about $15.00. To haul it across the continent by the transcontinental railway lines, would cost $25.00 to $35.00 a ton to New York alone, saying nothing of the Trans-Atlantic voyage. An idea can be obtained of the immense distances by which commerce now moves on its main lines by an examination of the table of comparative distances on pages 483–484.

The Mexican *Financier* in a recent article, used the following language:

"The Rocky Mountains of the United States, the Sierra Madre of Mexico, the Cordilleras of Central America, and the Andes of South America, form an almost continuous barrier, so lofty and extensive, as to be nearly impassible to man in his commercial pursuits. The railways that scale these

heights by an immense expenditure of money, seeking the business of the fertile valleys on each side, rise to an altitude of several thousand feet, soar up among the clouds, climb over the rocky barrier and descend the mountain sides by grades almost impracticable for the heavily loaded trains. These mountain barriers separate at least seventy millions of people living in Mexico, the United States and Canada, nearly all of whom would be benefited by the breaking down of this obstruction in their agricultural, manufacturing and commercial prosperity.

"To sum up these general statements, and to bring together these various features of the subject, the world needs a gateway through the mountains, a path broad and plain for the inter communications of the nations, on the shortest possible lines, for the transportation of the varied products which each nation has in surplus for the others' needs. More than most other nations, does the United States require that extension of her coast line from the east to the west, and the west to the east, which a navigable connection between the Gulf of Mexico and the Pacific will give her. More vitally still, though the magnitude of the commerce is less, does the Republic of Mexico need a union of her east and west coast lines across the Isthmus of Tehuantepec, as an auxiliary to the extensive and necessary railway system which this young republic has so heroically inaugurated at great present sacrifice, but for the future greatness and prosperity to which her wonderful natural resources entitle her."

When it is known, that the distance by rail from New York to San Francisco is about 3,300 miles, and that the Pacific can be reached from New York at the Isthmus at Tehuantepec, by an all-water route, nearly one thousand miles shorter, and that seventy per cent. of the Asiatic Pacific business and Australasian trade lies south of the latitude of Tehuantepec, the commercial necessity for the breaking down of the barrier between our Atlantic Coast and these countries is fully appreciated.

Particular attention is directed to the unfortunate position of the Mississippi Valley and its outlet, and the whole coast of the Gulf of Mexico, extending to Vera Cruz. This whole country is hid away as it were, and isolated from the countries to the west of it, and yet with inter-oceanic communication, it will be brought into close proximity to these countries. The immense surplus productions of the Mississippi valley and of the country contributory to the Gulf Coast, will then find a market on the western coast of South America, or our own western coast, or the Isles of the Pacific, or the far Pacific countries—Japan, China and Hindoostan.

Turning to the subject of manufactures, it may not be generally known that while immense quantities of goods of all kinds are turned out annually, the amount exported is insignificant. We manufacture

$420,000,000 of iron and steel; $185,000,000 of leather goods; $202,000,000 of woolen goods; $246,000,000 of cotton goods; $41,000,000 of silk goods; $24,000,000 of glass and similar products. But of all this immense amount of manufactured articles, we export not over *three per cent.* And yet the country at this present time, is passing through a period of very great business depression said to be largely due to *over-production*. With the markets of the world open to these surplus productions and the exports increased from three to even twenty per cent., the business depression will pass away. This permanent avenue of commerce will so regulate production and business in the future, as to place these periods of depression further apart and make them less injurious to the country.

The *London Times*, of August 21, 1884, in closing a very accurate description of the Tehuantepec Ship Railway project, uses the following very forcible language in reference to the benefit to commerce and to the world, which will surely come by the opening of this inter-oceanic communication:

"Looking at the ship railway project from a broad and general point of view, there can be little doubt that it is one which is fraught with great results. This will be better realized when it is remembered that the American Isthmus separates about 100,000,000 of the most enterprising, industrious, and enlightened people on the face of the earth, inhabiting the north Atlantic Coasts of Europe and America, from 600,000,000 who inhabit the Orient and the Islands of the Pacific. It is true that the sailing distances which separate England from India, China, and other oriental countries, have been greatly reduced by the Suez Canal; but these distances are almost insignificant when compared with those which the ship railway would annihilate. For instance, the greatest saving effected by the Suez Canal between London and Calcutta is about 4,500 statute miles; whereas the sailing distance by the ship railway from London to every port on the Pacific Coast of North America will be lessened by nearly twice this great distance, or about 8,250 miles. The Suez Canal brought London and Canton about 3,500 miles nearer together by sea. The ship railway would save more than three times that distance between the great American metropolis and every port in British Columbia. The American Isthmus and the Cordilleras of North America constitute a narrow, but almost impassible barrier to the interchange of the manufactures and productions of forty millions of people in the Mississippi Valley and the Atlantic States, not only with those of 10,000,000 of their countrymen to the west of them, but with the others on the islands and coasts of the Pacific who are seemingly their nearest neighbors. The ship railway would give to these descendants of the British Isles a sea route between their Atlantic and Pacific ports, scarcely a thousand miles longer than the railway between New York and San Francisco, and it would give to the vast Valley of the

Mississippi a gateway equivalent to the discharge of its mighty river directly into the Pacific. A work designed to confer such great benefits on the commerce of the world should commend itself with special force to this country, which is carrying more than seventy per cent. of that commerce."

THE GENERAL HISTORICAL DEVELOPMENT.

The early navigators and discoverers of America had for their object in their perilous voyages across the Atlantic, in their small ships, the discovery of a new route to the East Indies. Whenever these adventurous rovers landed on the Coast of North or South America, they immediately searched for a passage through the land towards the Indies. Over 300 years ago, Cortez attempted to pass through the Isthmus of Tehuantepec in his search for a passage to this coveted country. From that time to this, there has never been a moment when an interest in this interoceanic transit was not felt by all the commercial nations of the world. The growth of the great nation founded by the English in North America, whose millions partly on the Atlantic and partly on the Pacific Coast, are separated by mountain ranges, has made this necessity still greater until the time has arrived when its welfare and even prosperity is dependent upon this connection between its east and west coasts. Many surveys have been made; many projects brought to the attention of different nations; much money has been expended; governments have attempted to devise plans for overcoming this barrier to commerce; and it has been the study of the leading commercial and engineering minds of the world to present some practicable plan for meeting this great necessity of commerce and of the world. The question is forcibly and briefly put by the "London Engineering," in its issue of January 9th, 1885, as follows:

"The idea of carrying across the Isthmus of Tehuantepec, the commerce which flows backwards and forwards between the Atlantic and Pacific and Indian Oceans, was already old when the Pilgrim Fathers planted on the American continent the nucleus of a great nation. Cortez himself, sought for a natural way along the rivers which flow in either direction to the sea, and finding none, he purchased large tracts of land as an inheritance to his posterity, confident that in time the needs of the world and the advance of science, would carry a highway over this very spot. His descendants still hold these lands, which lie in the exact track settled by recent surveys as the route for the proposed ship railway, and thus they will reap the fruits of a piece of statesmanlike far-sightedness, which stands in remarkable contrast with the timidity and supineness of a generation which, having seen more marvels of science and engineering than the whole human race which preceded them, can scarcely be got to believe that it is

possible to raise a laden ship out of the water without breaking her back. During the three centuries that have elapsed since Cortez in his imagination, saw his grandchildren levying toll upon the oriental traffic which has enriched one nation after another passing, successively through the hands of the Arabians, the Phoenicians, the Venetians, the Portugese, and the Dutch, until it finally settled in England, the idea of cutting or crossing the narrow Isthmus which connects North and South America has never been long forgotten, and for the last quarter of a century there have always been some ardent minds at work upon it."

Not only have engineers had this subject in mind during these centuries, but the statesmen of this country and of Mexico have realized the great importance of an interoceanic transit, and have sought for it by various means—by concessions to companies formed for the purpose of constructing railroads or canals, and by treaties between the countries interested, uniting them as governments, in the construction of a transit-way. As early as 1835, President Jackson made inquiries into the state of the projects for uniting the Atlantic and Pacific Oceans through the Isthmus of Darien. In 1839 an elaborate report on the whole subject was made by the Hon. C. F. Mercer, of the House of Representatives. In 1846, the Secretary of State communicated to the Senate a number of valuable papers on the subject. In 1849, there was presented by the Hon. J. A. Rockwell, a report embracing 658 pages bearing on this subject. Including among the papers were reports of the surveys of the Isthmus of Tehuantepec, of Nicaragua and of Panama, and in relation also to the then proposed Panama Railroad. In 1851, President Fillmore said in his message to Congress, "in investigating upon this important subject, this government has had in view one and only one object. That object has been, and is, the construction or attainment of a passage from ocean to ocean, the shortest and best for travelers and merchandise, and equally open for all the world." Succeeding Presidents have taken up the subject and discussed its geographical and political features, and urged the construction of a highway from ocean to ocean. President Hayes in 1880, in his message to Congress stated the importance and necessity of this interoceanic communication across the American Isthmus, in the following forcible language:

"An interoceanic canal across the American Isthmus will essentially change the geographical relations between the Atlantic and Pacific Coasts of the United States, and between the United States and the rest of the world. It will be the great ocean thoroughfare between our Atlantic and our Pacific shores, and virtually a part of the coast line of the United States.

Our merely commercial interest in it is greater than that of all other countries, while its relations to our power and prosperity as a nation, to our means of defense, our unity, peace, and safety, are matters of paramount concern to the people of the United States."

Coming down to the present time, there is probably no stronger statement of this question, than that given recently by President Arthur, who speaking of the necessity for interoceanic communication, says:

"It is imperatively demanded by the present and future political and material interests of the United States. The establishment of water communication between the Atlantic and Pacific Coasts of the Union is a necessity, the accomplishment of which, however, within the territory of the United States is a physical impossibility. While the enterprise of our citizens has responded to the duty of creating means of speedy transit by rail between the two oceans, these great achievements are inadequate to supply a most important requisite of national union and prosperity. For all maritime purposes, the States upon the Pacific are more distant from those upon the Atlantic than if separated by either ocean alone. Europe and Africa are nearer New York, and Asia is nearer to California than are these two great States to each other by sea. Weeks of steam voyage, or months under sail, are consumed in the passage round the Horn with the disadvantage of traversing tempestuous waters or risking the navigation of the Straits of Magellan. A nation like ours cannot rest satisfied with such a separation of its mutually dependent members. We possess an ocean border of considerably over ten thousand miles on the Atlantic and Gulf of Mexico, and including Alaska, of some ten thousand miles on the Pacific. Within a generation the western coast has developed into an empire, with a large and rapidly growing population, with vast but partially developed resources. At the present rate of increase, the end of the century will see us a commonwealth of, perhaps, nearly a hundred million inhabitants, of which the west should have a considerable larger and richer proportion than now.

"From a purely commercial point of view the completion of such a waterway opens a most favorable prospect for the future of our country. The nations of the Pacific Coast of South America will by its means be brought into closer connection with our Gulf States. The relation of these American countries to the United States is that of a natural market from which the want of direct communication has hitherto practically excluded us. By piercing the Isthmus the heretofore insuperable obstacles of time, sea, and distance disappear, and our vessels and productions will enter upon the world's competitive field with a decided advantage of which they will avail themselves. When to this is joined the large coasting trade between the Atlantic and Pacific States, which must necessarily spring up, it is evident that this canal affords even alone, an efficient means of restoring our flag to its former place on the seas. Such a domestic coasting trade would arise immediately, for even the fishing vessels of both seaboards

which now lie idle in the winter months, could then profitably carry goods between the eastern and western States.

"The political effect of the canal will be to unite closer the States now depending upon railway corporations for all commercial and personal intercourse, and it will not only cheapen the cost of transportation, but will free individuals from the possibility of unjust discrimination. It will bring European grain markets of demand within easy distance of our Pacific, and will give to the manufacturers on the Atlantic seaboard economical access to the cities of China, thus breaking down the barrier which separates the principal manufacturing centres of the United States from the markets of the vast population of Asia, and placing the Eastern States of the Union for all purposes of trade midway between Europe and Asia. In point of time the gain for sailing vessels would be great, amounting, from New York to San Francisco to a saving of seventy-five days; to Hong Kong of twenty-seven days; to Shanghai of thirty-four days, and to Callao of fifty-two days."

In reference also to the business of Europe which will be affected by an interoceanic transit, Prof. J. E. Nourse, in his valuable work on the Suez Canal says in relation to the advantages which a crossing at the American Isthmus would have:

"It may be conceded that a portion of the sailing tonnage of Europe, trading with China, Japan and Philippine Islands, Borneo, Celebes, New Guinea, Australia and possibly Java and Sumatra, would pass through the route. Besides these countries, the western coasts of South America, and especially the California interests must come into view. A ship canal across our Isthmus would probably develop on these coasts, and under our advancing relations with China and Japan, new activities in commerce, equal if not superior to those which have been stated as stimulated by the opening of the Suez route."

Other important opinions might be given from men who have carefully studied the whole commercial subject to show the advantages which would accrue not only to this country, but to other countries of the world, by cutting through or going over the American Isthmus; but enough has been said to convince any one that the time has arrived for the work to be done, for the connection between the oceans to be made. It may be stated that the statesmen of Mexico from Cortez to the present distinguished President of Mexico, General Porfirio Diaz, have all been aware of the immense benefit to Mexico that would inevitably result from an inter-oceanic crossing at the Isthmus of Tehuantepec—one of the States of Mexico.

PRACTICABILITY OF THE SHIP RAILWAY.

Every project takes its position in the minds of men, according to the standing of the projector. This model which you see before you is the expression of the thought and the study of one of the best civil and mechanical engineers of the world—Mr. James B. Eads. His name is known to you by reputation, and it need only be said here, that from early life his attention and his work have been in the direction of civil and mechanical engineering. With the opportunities for only a meagre education in his youth, he has risen by study and observation of the laws of nature to his present position before the world. His achievements have been remarkable, and mark him as a man of genius. When the country was in the throes of rebellion he was asked by the Government to build seven powerful iron-clad steam-boats for use on the western rivers, and fit them with an exceptionally heavy armament all in one hundred days. The work was accomplished—although when he commenced, the wood with which they were built was standing in the forests and the iron was in the ore. In his business, later, in lifting the wrecks of steamboats, he examined the bed of the Mississippi River as no one else has had the opportunity of doing. The laws of nature as observed in that work by him, led him in later years to propose the improvement of the mouth of the Mississippi River by means of jetties, which have abundantly proven his theories to be correct. The bridge he built over the Mississippi River at St. Louis at a time when deep foundations were very rarely attempted, going down as they did, through 115 feet of shifting quicksands to the solid rock bed of the river, proved his knowledge of river hydraulics and constructive engineering to be sound, theoretically and practically. The bridge will stand forever as a monument of his genius, but his work and his fame are not confined to his native land. Canada, Brazil and England have called upon him for the solution of difficult problems in Engineering, and he was recently awarded the Albert medal by the Society of Arts of Great Britain—the only American who has received it. This subject, therefore, on which he has expended so much thought and study for the last five years is not the project of some irresponsible, unknown inventor, but of a man of genius, who has accomplished great things and whose inventions are acknowledged to be useful to individuals and to governments. This model illustrat-

ing this subject will speak to you more eloquently than it is possible for me to do.

Before explaining it to you, I will say that the subject of the transportation of ships is not a recent one. It was accomplished, as is well known, by the Athenians 400 years before Christ, when they transported their war ships over the Isthmus of Corinth; in the middle ages, by the Turks who transported ships of war in a similar manner; by Swedenborg, one hundred years ago in transporting three vessels of war across one of the peninsulas in the Baltic; and before the construction of the Suez Canal was commenced two noted English engineers, Brunlees and Webb, proposed a ship railway and made their plans for the work. It should, however, be stated, that the work that has been accomplished so far in moving vessels over land, has been on a small scale. The plans for the Tehuantepec Ship Railway are illustrated by this working model made, according to scale, from the plans of the full sized works.

At each terminus a basin is excavated, leading on the one side from the river, and on the other, from the lake, to a dock, which will be walled on the sides and on one end either by masonry or by timber. In this dock a pontoon will be placed, which, like an ordinary lifting dock, will be capable of raising the vessels. This pontoon will be made of steel plates, with bulkheads athwartships, and fore and aft, so as to give it the strength required to support the weight that it has to carry when out of the water. Its size will be about 450 feet in length, 75 feet in width and from 12 to 15 feet in depth. There will be connected with it on each side a water-tight tower, whose top stands above the surface of the water when the pontoon is submerged and grounded on the foundations of the dock. The pontoon is sunk by opening sluice gates; these sluice gates are in its side or bottom and are operated from the top of these towers. It is raised by means of powerful pumps which withdraw the water from the pontoon and discharge it into the surrounding dock or basin. These pumps as designed are sufficiently powerful to raise the pontoon with the largest vessel upon it in from 15 to 20 minutes. It is guided in its vertical movement by large anchor rods or weighted cylinders, which are securely anchored in the foundations of the dock. These rods pass freely through the pontoon, but are separated from its water spaces. The heads of these guiding rods or cylinders prevent the pontoon from rising above a certain level, and also resist its buoyancy when the vessel has been run off on to

the railway. In order to lift a vessel without injury to itself and to place it upon a cradle or carriage for transportation without any possible injury to this carriage, it is necessary to distribute or equalize the unequal weight of the vessel so as to bring no more load upon one part of the carriage than upon another.

A vessel has not the same weight per unit of its length throughout its whole extent, but being a girder capable of resisting the flexures and distortions which it must necessarily undergo in its voyage on the ocean, it is capable of sustaining without injury to its structural integrity, the equalization which it is necessary to make. In fact, when the vessel is in its natural element, smooth water, it is not equally borne by the water per unit of its length, from the fact that certain parts of the vessel have more buoyant power than other parts; for instance, the bow and stern of a steamer, or of any vessel have a tendency to droop, and it is often the case that after they have been built some years the ends of the keel are found to be below the central part. The equalization is accomplished by a system of hydraulic rams or presses which are built into the pontoon, and are founded upon a second deck about six feet below the main or upper deck. These rams are arranged in longitudinal and lateral lines, the latter being spaced about seven feet apart. The combined or total area of the rams in any one lateral line is exactly equal to the combined area of every other lateral line. There being seven rams in one of these lateral lines in the amidships section of the vessel, their area, if combined into one ram, would be exactly equal to the one ram under the bow or stern of the vessel. Approaching the bow or stern from the centre there are five rams in a lateral line; approaching still nearer the bow or stern there are three rams in each lateral line, and under the bow or stern there is one ram. These rams are all connected by means of water pipes, through which a pressure is applied to the whole system of rams, by means of a hydraulic pressure pump placed on the top of the towers on the side of the pontoon. These rams have a vertical movement of seven or eight feet. When the principle of hydrostatic pressure is understood it will be seen that any mass, whatever may be its shape, that rests upon this system of hydraulic rams when they are under pressure will be equally borne throughout its whole extent, providing it has a bearing upon all the rams in the system. In the case of a vessel, either a sailing ship or a steamer, this equalization is so perfect that the excess of weight in the central portion of the vessel,

when she is loaded, will be taken up by the lines of rams towards the bow and the stern, which have immediately over them a weight less than that which they are able to sustain. This system of rams is grouped by means of valves so that a greater pressure, if necessary, can be brought to bear upon one part of the vessel than upon another. In practice there would be a large number of valves so that the system could be applied to different sizes and shapes of vessels as each might require. It will be seen, therefore, that when the vessel rests upon this system of rams she is water borne, for she is resting upon so many columns of water under pressure, which equalize the weight of the vessel by a process which is similar to that employed by nature herself when the vessel is resting in her natural element. A pressure gauge is attached to the water pipes which will serve to show the exact weight of the mass that is borne on the system of rams.

As a body immersed has no stability, the pontoon which raises and lowers the vessels has no stability under water. As it will not always be possible to bring the centre of gravity of the vessel directly over the centre of the pontoon, there will be a tendency for the pontoon to come up out of level if there is more weight upon one end of it than upon the other. This probably would prevent the pontoon from rising by its binding upon the anchor rods which guide it. To prevent this the pontoon is balanced, not by water let into the compartments as in the case of a balance dock, but by a mechanical appliance called a hydraulic governor. These governors are located at the four corners of the pontoon and at other points along the side of the pontoon, if it should be found to be necessary in practice. They consist of a plunger working in a cylinder. The plungers are attached to the pontoon, and the cylinders to the dock outside. On each corner there is an inverted and an upright cylinder. The upright and inverted cylinders on the diagonal corners are connected with each other by means of pipes. The cylinders and the pipes are water-tight and are filled solid with water. Now, if there is, say 100 tons more weight upon one end of the pontoon than there is upon the other end, there will be brought upon the water in each of the two inverted cylinders at the heavy end of the pontoon a weight of 50 tons. The pressure due to this weight is immediately transmitted through the pipe to the upright cylinder on the diagonal corner, and the water in the top of this cylinder instantly reacts with a 50 ton pressure, as a plunger upon the metal plunger in the cylinder, and thus compels this

corner of the pontoon to go up or down with the same velocity and to remain at the same level as the diagonal corner of the pontoon with which it is connected; the same of the other corners. By this means the pontoon is made to rise and fall in a perfectly level plane, and consequently is always balanced so as to move freely upon the guiding rods. A pressure guage attached to the governor pipes will indicate the total excess of weight on either end of the pontoon. If it is too great for the governors to balance with safety or for the rams to equalize, the pontoon would be lowered and the position of the vessel shifted. On the deck of the pontoon and between the longitudinal lines of the rams are laid the rails for the carriage which is to transport the vessel. These rails are six in number and constitute three ordinary gauge tracks, each 4 feet 8½ inches. The outer rails are 29 feet apart between gauge lines. The carriage to transport the vessel is built of steel girders. As the vessel itself is a girder it cannot be easily bent out of its position, and as the rails resting upon an immovable road-bed are another girder, and the carriage simply moves between these two girders, its greatest strength is in its cross girders, the longitudinal girders being only of sufficient strength to carry the trucks which are placed under them. The cross girders are spaced about seven feet apart, exactly like the rams in the pontoon. They are supplied with a system of supports for the vessel, keel and bilge blocks. The keel block is continuous the whole length of the vessel, and is hinged in such a manner as to be adjustable to the shape of the vessel's keel. The supports under the keel block and the other supports of the vessel rest upon large steel rods, in which a thread is cut for an adjusting nut which can be run up or down on the rods. The upper end of these rods under the bottom and bilges of the vessel is supplied with an adjustable hinged surface which is arranged to move either way so as to be in effect hung on an universal joint. These surfaces have an area of about 12 square feet, and are cushioned with rubber or other material that will prevent injury to the vessel when it rests upon the supports. When these supports are in position they may be said to resemble in general shape an ordinary music stand.

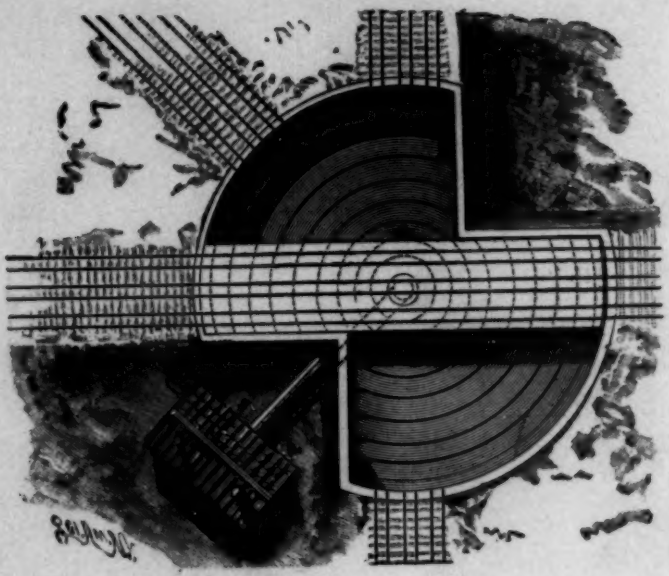
The process of lifting a vessel is as follows: The carriage is run from the railway upon the pontoon and locked in exact position upon it. The water is let into the pontoon by sluice gates, and it goes down with the carriage resting upon it until it rests upon the foundation of the dock, or at a sufficient depth in the water to

allow the vessel to be floated in over it without striking the supports of the carriage, which are previously let down by means of the adjusting nuts until the heads of the supports rest upon the girders of the carriage. The vessel is then brought in over the pontoon, and is located as near as possible with its centre of gravity over the centre of the pontoon. Adjustable guides from the side of the dock, working by hydraulic power, quickly and gently bring the vessel to a position centrally over the carriage; that is, its keel is directly over the keel block of the carriage. The pontoon pumps are now set at work, and the pontoon with the carriage upon it comes up under the vessel; just before coming in contact with it the hydraulic pumps on the towers of the pontoon, which actuate the rams, are set at work and they gently force up under the keel, the bottom, bilges and sides of the vessel the whole system of rams. The valves are then closed to prevent the water pressure from escaping from under the rams, and the pontoon pumps to lift the pontoon up out of the water with the vessel on it. As the vessel rises up out of the water, resting upon the system of rams, its weight becomes greater and greater upon them every moment, some of them being slightly depressed, some slightly elevated, and the equalization through the system goes on as the vessel rises, until when it is entirely out of the water its whole weight is distributed from stem to stern. While it is resting upon the supports, which also, as we have seen, rest upon the rams, the adjusting nuts are run down on the thread of the supports until they have a firm bearing upon the plates of the cross girders. When this adjustment has been made, which would require only a few minutes by expert men to accomplish, the valves are opened, the water pressure escapes from the rams and they recede downwards into the pontoon. The weight of the vessel has now been transferred from the rams to the carriage, and the equalization of the weight upon the carriage is as perfect as it was upon the rams themselves. Now as the girders of the carriage are spaced the same as the lateral lines of rams, if we arrange the same number of wheels with each girder, we then will have the same weight imposed upon every wheel, which is intended to be not over 8½ or 9 tons, which they will be able to sustain, for each wheel will be tested to 20 tons when it is manufactured. As it is a common practice of the railways of this country, and especially in England, to impose a greater weight than this upon the driving wheels of locomotives, it will be seen that this is an admissible load for the wheels.

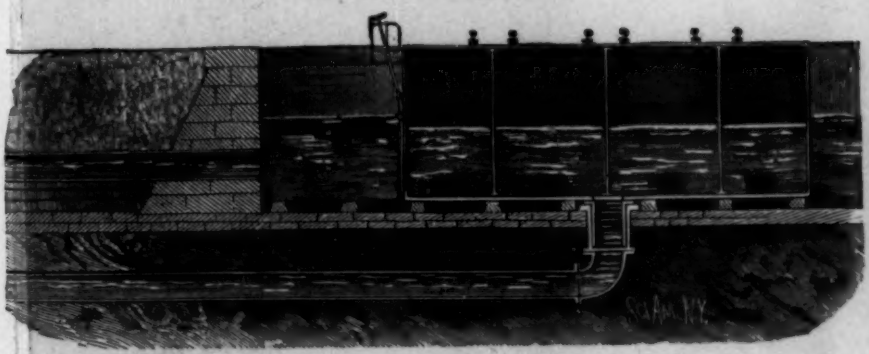
The wheels will be arranged in a truck of very simple form. As it is necessary for the carriage to move on practically straight lines, the wheels can be arranged with two flanges instead of one as a precaution against derailment, though the breaking of one wheel or of several wheels will not effect the integrity of the carriage. With each wheel is a powerful spring which will also be tested to 20 tons before closing. It has a vertical movement of six inches. When the maximum load of a 5,000 ton weight is placed upon the carriage these springs will be closed to within three inches. This gives an elastic bearing for the vessel and the carriage, and will serve two purposes; one to take up any slight irregularities there may be in the track, and the other to prevent any possible jar to the carriage or the vessel. When the load has been equalized upon the carriage it is evident that there will be no more weight brought upon the rails at any point than there is brought upon them by a locomotive on an ordinary railway. So that as far as the strain upon the rails is concerned, a rail of ordinary dimensions would answer the purpose. But as there is an immense concentrated and rigid weight to be moved, great strength and stiffness will be given to the whole superstructure, and the rails will weigh from 100 to 120 pounds per lineal yard, that is, they will be about twice as heavy as an ordinary railroad rail. These rails will be of steel and will rest upon long steel ties which extend under the whole six rails of the railway. They will be made of broad steel plates with a large bearing surface, and will be fastened securely to the rails. They will rest upon the best quality of stone ballast, or perhaps in some cases upon longitudinal timbers set into the ballast, or into concrete. The road-bed itself upon which this perfect superstructure rests will be constructed of the very best materials obtainable and in the most thorough manner. The embankments especially will receive the closest attention, and the greatest pains will be taken in order to secure a perfect and unyielding road-bed. Its width will be from 45 to 50 feet, so that there will be a wide shoulder outside the ends of the steel plated ties.

The motive power for hauling the loads will be locomotives of great traction power, which will have imposed upon the driving wheels at least 100 tons. As is readily seen, these locomotives can be attached directly to the load, three in front and three behind as pushers, if necessary. As the maximum load will be only 5,650 tons, it will not be difficult to haul it over the grades of the railway. The ordinary consolidated engines of the day will haul from 1,500 to 2,000

PLAN.



SECTIONAL ELEVATION.



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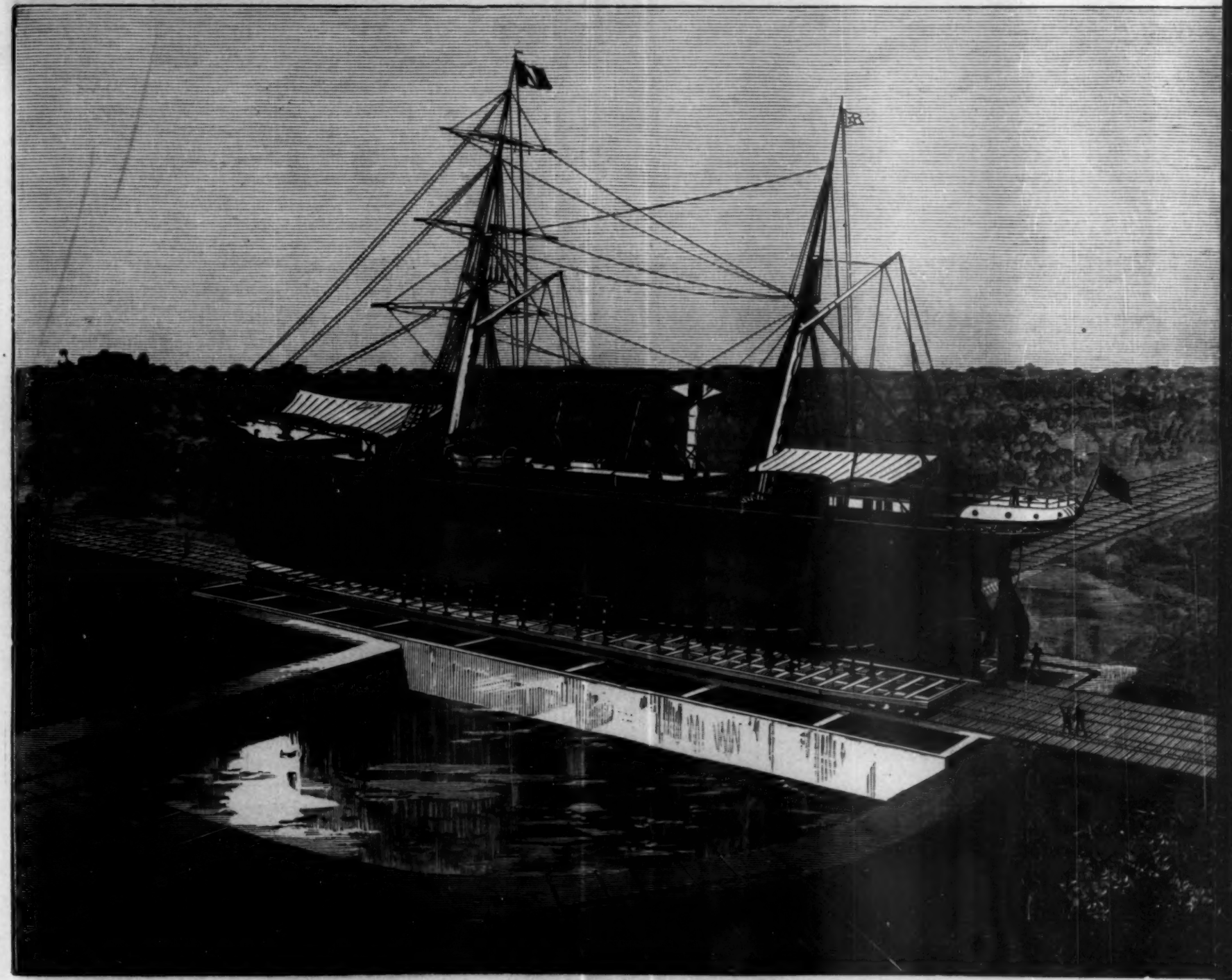

THE INTEROCEANIC SHIP RAILWAY.—THE FLOATING TURNTABLE.

tons without difficulty over grades up to twenty feet to the mile. Three such ordinary engines would, therefore, haul the maximum load; but with locomotives of double the power of these engines, no difficulty is apprehended in performing the work required, and at a fair rate of speed, which should not be less than from 8 to 10 miles per hour. As it has already been said, a carriage constructed after the manner described must necessarily move on practically straight lines, not perfectly straight, because it is ascertained that a movement in the journals of the wheels, and on their treads, will permit the use of a curve of 20 miles radius, which is practically a straight line. At points on the line, where such a curve as this would necessitate very heavy construction work in the shape of mountain cuttings or very high embankments, a change of direction to avoid them will be made by means of turntables. These turntables are very simple and economical in construction, maintenance and operation. They admit of a change of direction to any extent, and it is found that by their use a large amount of money is saved in construction. The location of the railway, which has been made with great care by instrumental surveys and detailed examinations of the country, is, through the rougher portion of the Isthmus, along a succession of valleys between high hills and mountains. In order to pass from one valley to another and take advantage of the natural lines of the country, these turntables are employed. Five of them only are necessary. They are built as follows:

A segmental basin of masonry is arranged to receive a pontoon. This pontoon is centred in the basin so that it will revolve around a central column, although it does not rest upon this column. When not revolving, the pontoon rests upon concentric bearing surfaces in the bottom of the basin. In order to turn a vessel it is run upon this pontoon; the water is then pumped out from the pontoon into the basin by means of a powerful centrifugal pump, until the pontoon rises sufficiently to be lifted from its bearing surfaces. It is, then, by means of stationary engines, worked by a cable or other means, turned about the central pivot, while floating upon the water until the rails on the deck of the pontoon correspond in line with those of the railway in the new direction. The water is then admitted to the pontoon by means of sluice gates or valves, until it grounds upon the concentric bearings in the bottom of the basin. The vessel is then run off

the pontoon upon the railway. When it arrives at the next point where a change of direction by this means is to be made, the same operation turns the vessel in another direction. At three of the five turntables, examinations show that water under a head from the mountain streams can be used to perform the work without the use of pumps. These turntables, while they are a necessity, will be utilized for two very important purposes; one for meeting points for vessels moving in opposite directions. A vessel moving from the Gulf of Mexico towards the Pacific meets another vessel at one of these turntables coming from the Pacific, by being run across the turntable on its arrival on to an extension of the track. The turntable is then revolved to take on the vessel coming from the other direction and it then goes on its way. The first vessel is then run back upon the pontoon and sent in its direction, the whole movement occupying but a short time. It will be seen that the weight of the vessel having been equalized upon the carriage by the hydraulic rams, if the centre of the carriage is brought over the centre of the pontoon, the latter will be balanced when it rises from the bearing surfaces in the bottom of the basin; but if the pontoon is not exactly balanced it can be brought level by letting water into one or more of the compartments on one end or the other of the pontoon. The second purpose, that the turntables will subserve, will be as dry-docks, where vessels can be run out on radial tracks built on each side of the segmental basin, where they can be cleaned, painted or repaired, as the case may be, and where they can remain as long as necessary. As every iron ship should be taken out of the water twice a year, the expense of docking will be saved, which is considerable for a large vessel. There will be one of these turntables at each terminus of the road near the dock, to facilitate the handling of the business at those points, and they will be located also at other points on the line where the operation of the road may show meeting points for vessels to be required.

The changes in grade on the railway will be made by very flat vertical curves. The elasticity of the vessel itself and the movement of the springs will allow a change vertically of two inches or more in four hundred feet. A curve established on this basis has been applied to the working profiles of the railway and found to be perfectly practicable in the construction of the railway.

The objections sometimes made to hauling laden ships overland are, first, that the vessel is out of its natural element; but it must be borne

in mind, as we have already stated, that a vessel in her natural element and even in a smooth sea, not buffeted by the waves, is not equally borne And then, when we consider the condition of the vessel when her natural element is disturbed, as it is almost always in a voyage, you will readily see that the strains of all kinds, twisting, bending, tortional and by flexures up and down, by shocks to her plates and rivets by the impact of the waves, by the bursting effect of her cargo (if there is any) by the sudden withdrawal of a great wave from her sides as the hollow of the wave passes along following so quickly its crest—that all these strains are greater than can possibly occur when a ship is borne on such a carriage, and on such a railway, as has been shown to you in this model. Prof. E. A. Fuertes, the Dean of Cornell University, in company with an engineer of high standing, measured the flexure of the steamer *Germanic* in in an ordinary sea-way, with the extreme points, which were taken for the experiment, only 264 feet apart (while the vessel is at least 400 feet in length). The experiment showed that the central portion of the vessel had an extreme movement, vertically of thirteen inches, or six and a half inches above and below a mean line. There is no doubt that if extreme points on the bow and stern of that steamer had been used there would have been shown a bending flexure in the centre of at least two feet, which goes to prove that a large vessel in a sea-way undergoes strains which would be injurious to her and break her to pieces, were she not specially built to undergo them. She passes through the ocean meeting these fearful strains upon her hull, and yet she comes into port without a leak—sound from stem to stern.

The second objection, that is sometimes raised, is the injury to the bottom of the vessel by lifting her with the cargo on board. An examination of the method of supporting the bottom as shown in this model, will dissipate this objection. It will be seen how much more thoroughly and carefully the vessel is supported than in any lifting or graven dock ever constructed. The vessel as you see is first water borne, as completely as she is in her natural element, on a system of hydraulic columns which hold her up and distribute her weight equally. The broad cushioned surfaces of the supports, their great number and their disposition are such as to make it easy and safe for a vessel to be taken on the railway. The ship after her stormy passage, tossed and buffeted by the waves will lie as restfully in this

adjustable system of water columns, as she would at her wharf in a quiet harbor.

A third objection, sometimes heard, is the wind pressure to which the vessel will be subjected. The shape of the vessel, which is shown in this model before you, the broad base upon which she rests, her great width at the bottom as compared with the height, and the side girths which hold her in their embrace, make it apparent that any vessel, that will not be blown over in the water, will remain unmoved on the carriage in which she is imbedded.

There have been many decided expressions of approval given by practical experts on this subject, by men who have designed, built, docked and handled ships in various ways, all to the effect that a vessel can be docked, laden, or she can be moved, laden, on a railway without injury to her. A few of these supporting opinions are here given. "A letter dated February 14th, 1882, from Mr. William S. Buckley, President of the New York Balance Dock Company, gives a list of five ships and six steamers, ranging from about 2,000 to 2,700 tons, that were taken out of his dock with cargoes in them." In this letter Mr. Buckley says:

"We do not refuse any class of ships or steamers, even with coals and cargoes on board, whose length does not exceed the length of the dock. In every case in which we have taken up steamers with cargoes in, it has been done without the least strain or injury to the vessel. As the rule is to make a charge for raising a cargo on a vessel, they usually come to us without cargo."

The late Edward Hart, U. S. Naval Constructor, in a letter to Mr. Eads, says (quoting a portion, only appertaining to this subject):

"With a substantial road-bed for your Ship Railway, on the easy grades across Tehuantepec, which I understand do not exceed one or two feet in the hundred, there can be no mechanical difficulty in the way of transporting loaded ships by railroad with entire safety to the vessels, whether they be built of wood or iron."

Mr. Hart was one of the oldest and ablest constructors in the U. S. Navy.

Mr. H. L. Fernald, a constructor of the U. S. Navy of recognized ability and talent stated in a letter as follows:

"Having carefully examined the plans and papers pertaining to the proposed Ship Railway across the Isthmus of Tehuantepec, I do not hesitate to say that in my judgment there will be no difficulty whatever in transporting in the manner you propose any properly built vessel with absolute safety."

The London *Iron*, of October 3d, 1884, in brief but comprehensive language, sets at rest any fears that may exist in the minds of timorous people in reference to the injury that vessels may sustain by being docked and handled with cargo on board :

"The question of endangering the structural integrity of a ship loaded with cargo by taking her out of the water and placing her on intermediate supports, is one which has frequently been raised only to be summarily disposed of by those who give the matter a moment's thought. As, however, there is still a popular notion that a loaded vessel under such conditions is subjected to injurious strains, it may be as well if we point out how utterly impossible this is by reason of the construction of the vessel itself. No greater fallacy than this was ever conceived, for there is no form of structure which is known to be subject to more unequal, irregular and ever-varying strains than a ship at sea, and these very points are carefully provided against in her design and construction. A properly designed and constructed ship resembles a girder, and is so built that no matter how she may be tossed about on the waves, the strains, conflicting and almost puzzling as they are, are distributed equally through her framing and plating or planking. If there was any fear of her cargo bursting her sides, as some have held there is, it would have burst them on her first loading, as although water is incompressible in confinement, it is exceedingly yielding when unconfined. Hence the risk of damage to vessels by straining during transport over land, may at once be set aside as puerile, especially in the face of the ingenious arrangement designed by Mr Eads for equalizing their support. Moreover, the raising of ships with their cargoes, from a lower to a higher level, by means of hydraulic lifts has been successfully accomplished for long past. The Victoria Docks, in London, and those at Malta, and Bombay, have been operated for years without an accident. Again it is a matter of common occurrence to keep loaded vessels for days, and even weeks, upon dry-docks for repairs, and then return them to the water without the slightest strain or injury."

The most valuable expert testimony that has been given on this subject is by Sir Edward J. Reed, K. C. B., late Chief Constructor of the British Navy. The testimony was given before the Committee on Commerce of the United States Senate. The following quotations are from his testimony and bear directly on this special subject:

"I have no hesitancy in saying that the marine ships of to-day are vastly stronger everywhere than they were half a century ago, and that they are now, as a rule, perfectly capable of being docked in dry-docks with their cargoes on board.

"I would like to say first, that there is no fear whatever of a ship undergoing any strain in the process of lifting out of the water (as would be necessary in case of a ship-railway), that she is not liable to at present in ordinary docking.

"I would say further that I am quite sure that the processes of ordinary

docking, as carried on in a vast number of private establishments, are very negligent and insufficient in comparison with those which would be adopted in case of the hydraulic lifts connected with the proposed ship-railway."

In reference to the hydraulic docks at Malta he gives a list of several vessels docked with their cargoes on board, and states:

"I would call attention to the fact that although ship owners were at first afraid of docking ships in that way with their cargoes on board, they have discovered by the experience of years that no sort of injury does result, for all the ships that are in the Indian Trade now voluntarily employ these docks, and go upon them with their cargoes on board for the purpose of getting their bottoms cleaned and coated on the voyage, instead of having to lie in a more expensive dock in London, for the purpose."

Mr. William Pierce, sole proprietor of the John Elder and Company's Works, Govan, Glasgow, and who built the *Arizona*, *Elbe*, *Alaska*, *Etruria*, and others of the finest steamers afloat says in a letter:

"I am of the opinion from what I know of the working of iron floating docks that I have designed and built, that iron steamers of 4,000 to 5,000 tons displacement, may be docked, loaded, without any injury whatever."

Commander T. D. Wilson, Chief Constructor of the U. S. Navy, states as follows:

"I see no good reason why any vessel cannot be successfully raised and transported upon a properly constructed railway, with a grade, as stated, if reasonable skill and care are used in the work, and I believe the strain she will be subjected to will be inferior to those which ocean steamers are constantly exposed to."

Sir John Fowler, a distinguished civil engineer of Great Britain, has himself proposed and designed plans for transporting vessels over land from one level to another, at the First Cataract of the Nile. Mr. Nathaniel Barnaby present Chief Constructor of the British Navy, has stated that the problem of carrying loaded vessels on a railway was not only soluble, but that the solution was fairly indicated in the plans shown him by Mr. Eads. Mr. William John, for some years the scientific adviser of the Committee of Lloyds Register, stated that the lifting of vessels out of the water having become an every day occurrence, the work of placing them on a carriage and transporting them was a simple matter. Mr. George Fosbury Lyster, Engineer in Chief of the Liverpool docks closes a decided opinion on the subject by saying:

"There will, in my judgment, be little or no difficulty in transporting properly constructed ships from sea to sea with entire convenience and safety."

The firm of Emerson, Murgatroyd and Company, who constructed the great hydraulic docks at Malta and Bombay, agreed with Mr. Eads that they would lift, for the Tehuantepec Ship Railway, loaded ships and place them on a carriage, and then place them on the permanent way, in thirty minutes, agreeing also to build the carriage and locomotives and ten miles of the railway and to guarantee the safe transportation of the loaded vessels over the railway. Messrs. Leader Williams and B. Baker, both prominent Civil Engineers of England, Professor Elgar, General Manager of Earl's Ship Building and Engineering Company, and Mr. Martell of Lloyds, have given strong testimony to the entire practicability of a ship railway.

After canvassing this whole subject of the practicability of a ship railway the Senate Committee of the United States Congress summed up the evidence as follows:

"The testimony upon the subject is so over-whelming and conclusive in its character that the Committee has no hesitation in reporting that the construction of a ship railway and its successful operation are entirely practicable."

Within the last two months and a half this working model of a ship railway has been shown to at least ten thousand people in New York, Pittsburg and Washington, many of whom were practical experts in building and handling vessels.

The general opinion as far as I know, without an exception, has been in favor of the practicability of taking vessels overland from ocean to ocean. The objections which many practical men have in their minds are met by the very simple and yet very complete appliances shown in this working model.

THE ROUTE.

As is shown on the map of the world the location for the ship railway is at the Isthmus of Tehuantepec in Mexico, north of, or rather west of, the Promontory of Yucatan. The length of the railway is 134 miles between the terminal points. The country along the route is naturally divided into three divisions,—the Atlantic, Central and Pacific Divisions. The water shed on the Atlantic or North Side is drained by the Coatzacoalcos River. At the mouth of this river is a bar formed by sedimentary deposits, over which there is a least depth, at present, of fifteen feet. This bar can be easily and economically

removed by the means of jetties, concentrating the river current like those at the mouth of the Mississippi River. Inside the bar is a wide and deep anchorage, large enough for all the inter-oceanic commerce. The river for twenty-five miles to Minatitlan is broad and deep, and except at one or two points will carry a good twenty-six foot channel. At Minatitlan the railway commences, the terminal dock being in a bend of the river where there is from thirty to forty feet of water. By locating the terminus at this point the marshes and swampy grounds which exist in the lower region of the Coatzacoalcos River, are avoided and the railway starts on high and hard ground. A gentle ascent extends from Minatitlan to the central division, through a country partly wooded and across rolling prairies. In the Central Division the line passes through a series, or succession, of valleys, bordered on each side by mountains and hills, spurs of the main Cordilleras. The line passes across the level plain of Tarifa and through the Tarifa Pass, which is the lowest pass on the Isthmus. The highest point of the route is 726 feet above the mean level of the ocean. From the Tarifa Pass to the Pacific Plains the line follows a succession of narrow valleys along the beds of the mountain streams, and reaches the plains by a continuous grade of one per cent. or $52\frac{8}{10}$ feet per mile. This is the only one per cent. grade on the whole line, the others being considerably less and most of the line being practically level. Across the Pacific Plains there are no obstructions, the ground being of hard, sandy material extending to the Pacific. The terminus on the Pacific side will be on one of the lakes or lagoons, shown on the topographical map. At the natural outlet of the lower lake, at Boca Barra, the deep water of the ocean approaches very near the shore line so that jetties 3,000 feet long will reach 36 feet depth of water. Some dredging to make a deep channel through the lagoon will be necessary and a harbor inside the jetties will be excavated where there is now from 18 to 24 feet depth of water. Building materials of the best kind of timber and stone are available along the line of the railway. The climate is exceptionally good. A party of engineers, nearly all of whom were unacclimated, were sent to the Isthmus in March, and were able to work through the rainy season without sickness. The Isthmus is inhabited, especially on the Pacific Side and in the Central Division, by a hardy, industrious, agricultural Indian population. Careful estimates made of the number that can be obtained for the construction

of a ship railway show that ten thousand at least will be available for that purpose.

I have no hesitation in saying that it is entirely practicable to build and maintain a railway that will carry the loads that will be imposed upon it. More than that I will say that the engineering difficulties and obstacles met with in the construction of the New York, West Shore and Buffalo Railway, between New York and Buffalo, just completed, were much greater than they can possibly be on the Tehuantepec Ship Railway. The construction of the New York terminal, in soft mud, over one hundred feet in depth, the steep river slopes on the Hudson River, which required peculiar constructions, the sliding materials met with at several points on the route, the cutting into the clay hillsides along the Erie Canal and the construction of the immense retaining walls necessary for long distances required much more skill, and I might say, much more money, than will be required in fully completing and equipping a ship railway across the Isthmus of Tehuantepec.

ADVANTAGES OF THE ROUTE AND THE METHOD OF TRANSPORTATION.

In alluding to other projected routes for inter-oceanic transit, and other means of accomplishing that transit, it is not intended to depreciate them, or to show that they are constructively impracticable, but simply for the purpose of showing the reason for the inception of the project for a ship railway. The *advantages* of the Tehuantepec route, and of the ship railway, were of course the prime cause of the inception of this project discussed to-night. The great detour required by commerce to cross the Isthmus at other points, and the immense cost of constructing the proposed ship canals led to the belief that the transportation of ships overland was the final and only solution of this great problem which had for centuries absorbed the attention of commercial men and engineers.

A glance at this map of the world will show at once, without giving any figures, the immense advantages in distance that the Tehuantepec route has over the Panama or the Nicaraugua routes. The distance in an air line from the Tehuantepec Ship Railway line to that of the Panama Canal is over 1200 miles, a distance hardly appreciable until we compare it with some well known distance with which we are familiar. This distance if stretched to the westward in a straight line from New York, would reach 50 miles west of Omaha; or if southward from

New York it would reach the centre of the Florida Straits. In other words, the Tehuantepec route is that much nearer to the United States than the Panama Canal. When we consider also that vessels making the voyage from Boston, New York, Philadelphia or any Atlantic ports, but particularly from the Gulf ports, must partially double the distance in order to reach San Francisco and other Pacific ports (Honolulu or Yokohama or any of the ports lying in that direction), we can see what an immense saving of distance there will be by the Tehuantepec route. The two great points to unite by the shortest possible line for the United States are San Francisco and New York or other points lying near these two. The nearer the route can be to a straight line drawn between these two points, the greater is the saving in distance and this is what an inter-oceanic communication is intended to accomplish. From a table before me giving the distance by several routes on certain main commercial lines of the world, furnished by the Superintendent of the United States Coast and Geodetic Survey, you will see the immense saving of distance by the route proposed, over the present sailing and steamer routes by Cape Horn; Cape of Good Hope, Suez Canal and the Panama Railroad, or Canal.

If the saving in distance by the Tehauntepec route on 18 principal lines of commerce is summed up, we have a total of 125,000 miles, equal to five times the circumference of the earth. The distance saved by the Tehuantepec route over the present Cape Horn route between San Francisco and Liverpool, is about 8,000 miles, equal to the diameter of the earth, and saving in time about two and a half months to a sailing vessel. The distance saved between San Francisco and Boston, New York and Philadelphia is about the same. When the magnitude of this saving of distance is taken into account, the immense benefits to arise from these shortened lines of commerce, will be appreciated by every one.

As Commodore Shufeldt said in 1871, in an official report of his survey of the Isthmus of Tehuantepec, "each Isthmus rises into importance as it lies nearer to the centre of American commercial interests; any intrinsic value of this eminently national work ought to be based upon the inverse ratio of the distance from that centre." An all-water route by way of Tehuantepec connects the east and west coast lines of the United States and Mexico, and as has been stated, renders our own territory circumnavigable, as it were.

Table of Comparative Distances in Statute Miles.

	Total Distance. Miles.	Excess over Tehuantepec route. Miles.
FROM NEW YORK TO HONG KONG.		
Via Cape Horn	20,379	8,777
Cape of Good Hope	16,945	5,343
Suez Canal	13,506	1,904
Panama R. R.	12,953	1,351
Isthmus of Tehuantepec	11,602	
NEW YORK TO AUCKLAND, N. Z.		
Via Suez Canal	16,871	7,447
Cape of Good Hope	16,719	7,295
Cape Horn	13,890	4,466
Panama R. R.	10,305	881
Isthmus of Tehuantepec	9,424	
NEW YORK TO MELBOURNE.		
Via Cape Horn	15,215	4,150
Suez Canal	15,171	4,106
Cape of Good Hope	15,019	3,954
Panama R. R.	11,828	761
Isthmus of Tehuantepec	11,065	
NEW YORK TO SAN FRANCISCO.		
Via Cape Horn	15,687	10,797
Panama R. R.	6,063	1,173
Isthmus of Tehuantepec	4,890	
LIVERPOOL TO YOKOHAMA.		
Via Cape Horn	19,400	5,945
Cape of Good Hope	17,653	4,198
Panama R. R.	14,540	1,085
Isthmus of Tehuantepec	13,455	
LIVERPOOL TO AUCKLAND, N. Z.		
Via Cape of Good Hope	16,221	3,412
Suez Canal	14,645	1,836
Cape Horn	13,897	1,088
Panama R. R.	13,312	503
Isthmus of Tehuantepec	12,809	

Table of Comparative Distances in Statute Miles.—Continued.

	Total Distance. Miles.	Excess over Tehuantepec route. Miles.
LIVERPOOL TO SAN FRANCISCO.		
Via Cape Horn	15,803	7,527
Panama R. R.	8,885	609
Isthmus of Tehuantepec	8,276	
NEW ORLEANS TO HONG KONG.		
Via Cape Horn	20,804	10,531
Cape of Good Hope	17,485	7,212
Suez Canal	15,108	4,835
Panama R. R.	12,308	2,035
Isthmus of Tehuantepec	10,273	
NEW ORLEANS TO MELBOURNE.		
Via Suez Canal	16,683	6,947
Cape Horn	15,640	5,904
Cape of Good Hope	15,560	5,842
Panama R. R.	11,181	1,445
Isthmus of Tehuantepec	9,736	
NEW ORLEANS TO SAN FRANCISCO.		
Via Cape Horn	16,112	12,551
Panama R. R.	5,418	1,857
Isthmus of Tehuantepec	3,561	

There is another immense advantage which the Tehuantepec route has over that of Panama, in fact over any other, namely, the advantage of winds and currents which are always favorable for sailing vessels on either side of the Tehuantepec Isthmus, and always unfavorable for them on either side of the Darien Isthmus. Every navigator will testify to the correctness of this statement. I would refer here to Commander Selfridge, of the United States Navy, who has explained the matter in an official report. The reasons for this difference in winds and currents are: The peculiar configuration of the islands lying to the east of the Carribean Sea and the great altitude of most of them compel the trade winds coming from the northeast, as they approach to rise into the upper air, so that they do not reach the Isthmus at Darien. The Andes and the Cordilleras carry these winds

still higher, and make a region of perpetual calms in the Pacific Ocean west of the Darien Isthmus—or rather of "doldrums" as they are called, for the conditions are "calms, squalls, light baffling winds and storms of wind and rain." At Tehuantepec the northeast trades reach down to it and pass through the low depressions into the Pacific Ocean. The former harbor of Tehuantepec on the Pacific side was called "Ventosa," which means "windy." But by far the strongest statement, and the most convincing, because of its high authority, is that of Lieutenant Maury, the great geographer, who in eloquent language thus describes the Gulf of Mexico and its commercial resources:

"From the Gulf of Mexico, the great commercial markets of the world are down hill. A vessel bound from that Gulf to Europe places herself in the current of the Gulf Stream, and drifts along with it at the rate, for part of the way, of eighty or one hundred miles a day. And when there shall be established a commercial thoroughfare across the Isthmus, the trade winds of the Pacific will place China, India, New Holland and all the islands of that ocean down hill from this sea of ours. In that case, Europe must pass by our very doors on the great highway to the markets both of the East and West Indies. This beautiful Mesopotamian sea is in a position to occupy the summit level of navigation and to become the great commercial receptacle of the world. Our rivers run into it, and float down with their currents the surplus articles of merchandise that are produced upon their banks. Arrived with them upon the bosom of this grand marine basin, there are the currents of the sea and the winds of heaven, so arranged by nature that they drift it and waft it down hill and down stream to the great market-places of the world. Never was there such a concentration upon any sea, of commercial resources; never was there a sea known with such a back count y tributary to it."

The conditions that we have given in reference to the winds and currents, are very important to American commerce. It has been stated that sailing ships are giving way rapidly to steamships; but from the late report of Mr. Jarvis Patten, the United States Commission of Navigation, we are disposed to believe that the sailing ship still holds its own; for he gives the total number of sea-going sailing ships owned by citizens of the United States, as 6,214, with a tonnage of 2,099,218, while there are but 422 steamships, with a tonnage of 601,186. Another very important statement made by him is this: That we in this country with our excellent woods, which can be obtained at reasonable prices, can build sailing ships at from $50 to $55 per ton; but that it costs us to build iron sailing ships from $65 to $75 per ton. On the other hand, it costs in England to build wooden sailing ships $75 to $80 per ton; but they can build iron ships at from $50 to $60

per ton. It is therefore very important for our American commerce, and our merchant marine, that the interoceanic route should be located where it can be used to advantage by our sailing ships. The importance of this will be appreciated by every commercial man along the Atlantic and Pacific coast, for we are still building these fine wooden sailing ships for the San Francisco trade, and for other sea-going commerce.

I will state further in reference to the Panama Canal now being undertaken by the French, that the immense cost, probably not less than $250,000,000, the great length of time required for its construction, the cost of maintenance where the bed of the canal is so far below the torrential streams and the clayey slopes of the excavations, one of them 500 feet in height, exposed to the exceptional rain fall of the topics, render it economically impracticable.

In reference to the Nicaragua route, certain very grave objections and obstacles exist. Its great length, 186 miles, the locks necessary for vessels to pass through, from 12 to 20 in number, the time required for passing through the canal, (not less than four days), the ruined harbor at Grey Town which will require probably $14,000,000 to restore, its immense cost, which by the estimate of Major McFarland, of the United States Army Engineers, is $140,000,000 based on labor at $1 only per day, or that of Captain Bedford Pim, of the British Navy, who states that it will cost $200,000,000; the obligations to which we commit ourselves that will entangle us with England, with Nicaragua itself, and with the adjacent Central American States; the purchase of a strip of land in a foreign country; the loan to be made to the State of Nicaragua of several millions of dollars; the guarantee to defend the canal; the powerless condition of our navy at present, to comply with any such agreement—all these render it inadvisable to enter upon such a work. If this country wishes to control an interoceanic crossing, and to be able to defend it, let it adopt a route that is capable of defense. At Tehauntepec, with a favorable treaty with the Government of Mexico, and by means of railway lines that are being extended from the United States to the Mexican Capital and beyond even to Tehuantepec with money furnished by our citizens, a land force of 100,000 men could be quickly transported from the Pacific Coast, the Mississippi Valley and the Atlantic Coast to meet an invading force. The Gulf of Mexico (if we have a navy that can do any defensive work) can be easily protected, as the only two outlets from it to the ocean are, one at the Florida Straits, and the

other between Yucatan and Cuba. This route is vastly superior to any other as a strategic point. Mexico is a sister republic, bound to us with ties that are growing stronger and stronger with every dollar of American money that is spent on her soil, in building her railroads and other constructions for the development of that country. She has a population of 12,000,000. Free at last from the harassing complications which invasions of her soil by foreigners and over turning of her legitimate Governments have brought upon her, she has become a strong republic, well advanced in agricultural, industrial and commercial pursuits, and a powerful ally of the United States.

There have been constructed within the last two or three years in Mexico 2,525 miles of railroad, at an expense of $60,000,000, two-thirds of which have been furnished by citizens of the United States. Her imports have increased from $5,000,000 to $10,000,000 in the last six years, and her exports from $6,000,000 to $12,000,00; and her revenues have doubled within four years.

There are four main longitudinal trunk lines of railroad building and in course of construction, from the American border. With great liberality she has subsidized these railroads and assisted in every possible way the development of her resources by means of railways and other improvements. She has given to Mr. Eads as projector of the Tehuantepec Ship Railway a valuable concession, which, while it brings with it no subsidy, gives certain other advantages which are of much greater importance. The present status of the ship railway enterprise is briefly given by saying that a company has been formed during the last two years, which owns the concession and which has furnished the necessary means for the preliminary expenses, making the surveys and plans and performing other work necessary to bring the project before capitalists. Important steps are now being taken, and if the object in view is reached, it will be but a short time before the plans will be carried into execution; and instead of seeing by the imagination of an artist, a ship moving among the palms of the tropics, as you have seen on the canvass to night by the lantern slides kindly furnished by your Secretary, you will be permitted to witness it in person on the Isthmus of Tehuantepec.

COMMERCIAL RESULTS.

The question often asked is, "Will it pay?" It is necessary to satisfy capitalists on this point before they are willing to put their means into an enterprise of this magnitude, which according to estimates from actual surveys, will entail an expenditure of about $50,000,000. To those who are so inclined, a study of the details relating to the commerce which may be expected over the ship railway by the year 1889, when it may possibly be completed, will prove conclusively that at least 6,000,000 tons can be counted upon as certain, probably more, and that as the years go on and as commerce increases and is drawn more and more to this route, a larger amount still may be anticipated. The Suez Canal can be used as a precedent in this matter. That has now reached the amount of 6,000,000 tons as was anticipated by Mr. De Lesseps when the work was first commenced. 10,000,000 tons is expected in 1888. The revenue for the year 1883 was $13,702,413. The dividend for 1882 was 17 per cent. The dividend expected in 1890 is 30 *per cent.* The location of the American Isthmus in reference to commerce and the varied necessities which the opening of an all water route will meet, promise certainly a business fully equal to that of the Suez Canal.

These are the results to the commerce, of not only this country but the world. These are also the important results to industrial pursuits and through them to the welfare of the nations. But still a greater result will be accomplished. With the Suez Canal and the Tehuantepec Ship Railway opened, not only commerce, but Christianity also will girdle the world. The last barrier will be broken down. Heathendom will be brought to the door of Christianity and to the feet of the Great Teacher. China, Japan, Hindoostan and the Islands of of the Pacific, to New York and Philadelphia. This object is more worthy of our steadfast and determined purpose to build the ship railway than all others.

The far Pacific countries will then be near neighbors to Massachusetts Bay, Sandy Hook, the Delaware, the Chesapeake, the Mississippi River and Galveston Bay.

Therefore, in conclusion, we say to capitalists, give us of your means; to men of commerce and trade and manufactures, give us your co-operation; to men of science and of civil and mechanical engineering constructions, give us your help and suggestions; to men devoted to

spread of morals and religion, give us your sympathy and your God speed in the great task before us; desiring you all to understand, that, confident in the immutable laws of Nature, we are therefore, confident of success, and are determined to achieve it.

[Referring to Plate I of detailed illustrations, Fig. 1 shows the process of running down the adjusting nut of the supports to a bearing on the plates of the cross girders. The details of the support are shown in Fig. 4, with the hydraulic ram forcing it up to its position under the vessel. *A*, is the rod with the thread cut in it; *B*, the adjusting nut; *C*, the girder; *D*, the ram.

Fig. 2, Cross-section of the pontoon, towers and carriage. *A*, is a side support; *E*, *G*, *F*, the adjustable hinged girth; *D*, the ram; *LL*, the towers for the pressure pumps which are on the top of the towers; *I*, is the pipe through which the water is withdrawn from the pontoon by the centrifugal pump; *J*, is the reservoir from which the water is taken to force a pressure through the pipes to the rams; *K*, is one of the cylinders for the hydraulic governors.

Fig. 3, shows a part of the deck of the pontoon with the rails and the lines of rams projecting above the deck.

Plate II is a perspective view of the pontoon and railway cradle.

Plate III exhibits perspective view, plan and sectional elevation of the floating turn-table.

Plate IV is a view of a steamer in transit.

Plate V exhibits Tehuantepec as the centre of the world's commerce.]

Polar Spots upon Venus.—Trouvelot confirms the measurements of Bouquet de la Grye and Arago on the photographs of the Venus transit. Since his first recognition of the polar spots in 1877, the southern has always appeared more visible and more brilliant than the northern, and towards the end of January, 1878, a short time before the inferior conjunction of Venus, the southern spot often looked as if it was composed of numerous very brilliant peaks, which were outlined in profile on the sky. On many of the photographs of the transits of 1874 and 1882 there is a curious swelling in the luminous aureole which surrounds the planet. It would be interesting to ascertain whether this swelling corresponds with the position of the polar spots at those periods.—*Comptes Rendus*, June 16, 1884. C.

Contour of Venus.—Messrs. Bouquet de la Grye and Arago have communicated to the French Academy some interesting results obtained by examining photographic plates of the transit of Venus. The principal object of their measurements was to determine the distance between the stellar and planetary centres upon each plate in order to calculate the solar parallax. For his purpose they made microscopic observations of the contour of each disc and found a protuberance amounting to 116 kilometres (72·08 miles). There are four other manifestations of protuberances which are of less magnitude.—*Comptes Rendus*, June 9, 1884. C.

FAC-SIMILE TELEGRAPHY.*

By Prof. Edwin J. Houston.

A system of fac-simile telegraphy includes the means whereby handwriting, pen sketches, outlines, hieroglyphics, etc., produced at one end of a telegraph line, are automatically reproduced at the other end. A system of fac-simile transmission comprises a transmitting and a receiving apparatus. This apparatus consists, for the greater part, of similar surfaces maintained in almost synchronous motion. The message is written on one of these surfaces, and received automatically on the other, where it is reproduced.

The means whereby the messages can be transmitted and reproduced, may be divided into two general classes, viz., In one of these classes a series of electrical impulses, interrupted or completed at periods dependent on the nature of the message to be sent, are transmitted by means of an apparatus at one end of the line, and reproduced at corresponding points on a similar apparatus at the other end.

In the other class, a stylus or pen, moved by the hand, while under the influence of an electro-magnetic field, sends an induced electrical impulse over the line, which causes similar movements at the other end of the line.

Fac-simile telegraphy is by no means a thing of to-day. It is an old invention. As early as 1843, Bain invented a device which he called a method of "taking copies of surfaces," such for instance as printer's type, etc., at a distance, by means of similar instruments placed at the extremities of a telegraph line, and maintained in as nearly synchronous motion as possible.

In 1850, Bakewell, of London, invented a device for transmitting autographic messages. This consisted of two entirely similar cylinders driven at a uniform speed by clockwork, and maintained at an approximately uniform synchronism by means of breaks operated at small periodical and adjustable intervals by the action of a local battery and pendulum.

In 1852, Hunter made improvements in fac-simile telegraphy. These improvements related mainly to the preparation of the copy to be transmitted.

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* Substance of remarks at the Stated Meeting of the Franklin Institute, held Wednesday, March 18, 1885.

In 1855, Jones made certain improvements in fac-simile telegraphy by means of which "characters formed at one station are reproduced at another distant station by the agency of electricity." "The transmitting instrument consists of two frames or boxes placed at right angles with each other," each of which incloses a set of cog-wheels with a communicating apparatus. A pencil lever holding a pencil is connected by rods and universal joints to each of the cogwheels so that the axes indicate the movements of the pencil, fixed to the lever, by transmitting and breaking currents of electricity. This, it will be seen, was a device by which the motion of the pen at one end is reproduced at the other. The instruments were so arranged that the making and breaking of the currents produced fac-simile movements of the pencils in the reproducing apparatus.

In 1858, Caselli, an Italian, devised a plan whereby fac-similes of handwriting and drawings were transmitted by electricity with greater rapidity than by any other method then devised. The means were as follows: The motive power was an ordinary clockwork; the rotation of the cylinder was not continuous, but intermittent, the necessary regulation being obtained by means of a pendulum driven by electro-magnetism. Caselli styled his apparatus the "pantellegraph," and constructed it so as to receive and transmit at the same time. The greatest rapidity he attained was, I believe, one square inch of surface covered in a minute.

In 1856, Thurrell, Müller, and Chidley, jointly invented certain improvements in transmitting fac-simile copies of writings and drawings by means of electric currents. In this form of apparatus a magnetized point or roller was caused to move to and fro over the surface of the transmitting cylinder. As long as the magnetizing current was passed, the point would trace on the cylinder a continuous line, but as soon as there was a break in the current the point was drawn away by a spring. As in the previous devices the message or despatch, written in some non-conducting ink, caused a break in the current whenever the conducting point passed over it. On the cessation of the current the magnetized point, moving over the receiving cylinder, was drawn away from the magnet and a break made in the continuity of the line it was producing. The successive breaks so obtained reproduced on the receiving cylinder the design traced on the transmitter.

Myers invented an autographic telegraph for the production of fac-simile copies of handwriting, which does away with the chemically

prepared paper ordinarily employed. In nearly all fac-simile telegraphs, the electrical current is caused to trace a line by means of chemical decomposition as it passes over the surface of the cylinder. When it passes over the chemically prepared paper it causes a decomposition of the material in which the paper has been steeped or soaked. In the apparatus of Myers, he does not produce his writing in this way, but employs in its place markings or tracings produced by a marking point worked by an electro-magnet.

Lenoirs invented an autographic telegraph something similar to that employed by Bakewell. The record, however, instead of being made by chemical action was produced by an electrically controlled magnetic device.

W. E. Sawyer invented an automatic telegraph which was an ingenious device. The message was written with ordinary ink on any stiff paper, dusted with powdered shellac and then transferred by powerful pressure to a zinc plate.

Bonnelli's autographic telegraph consists in a device by which the message set up in ordinary type at one end of a telegraphic line, is reproduced at the other end on a sort of chemically prepared paper by means of makes and breaks that take place as the conducting wires are drawn over the surface of the type.

Edison exhibited at the International Electrical Exhibition of Philadelphia an automatic telegraph for fac-simile transmission of despatches in Roman letters. This apparatus was similar to Bonnelli's in the fact that the message was transmitted in Roman letters. They differed, however, in that whereas the former set up or prepared its message for transmission in type, Edison, by an ingenious device, stamped the message in a fillet of paper. He had a series of punches which were grouped together like the keys of a piano, on which the letters and figures were marked. If he pressed his finger on one key, a certain group of punches would instantly cut in the paper fillet a series of equally grouped circular holes, so that the letter would be cut in the paper in a series of holes something like a stencil. When, therefore, the conducting points were drawn over the cylinder, as they pass over the perforations they drop down and complete the circuit on a metallic cylinder on which the paper rests and so produce similar marks on the cylinder at the other end. Edison also exhibited an autographic telegraph for fac-simile transmission.

As regards the details of Mr. Delany's system of fac-simile trans-

mission, I wish to say that I am in somewhat of a quandary in regard to this evening. I was invited to make remarks on the Delany Fac-simile Telegraph, some days after the announcement was put on the card. I do not at this time intend to explain the details of this system, since Mr. Delany, for reasons which will be understood by every inventor here, does not wish me to disclose them. I have, however, some messages sent by this system over a single telegraph wire, which I will afford you an opportunity for examining.

You are all doubtless aware of the fact that Mr. Delany, by the invention of his system of synchronous-multiplex transmission, has been singularly fortunate in obtaining what others tried in vain to obtain, viz., almost absolutely perfect synchronism. He has been able to maintain the uniform rotary motion of two cylinders, and to keep them running in accord with one another for months, although thousands of miles apart, without a variation of the one-hundredth part of an inch in their movements.

Mr. Delany's system of multiplex transmission is not a matter which is simply down on paper, but is being carried on every day on commercially established telegraph lines.

You will readily understand from what I have said of other systems of fac-simile transmission, that the synchronous-multiplex system might be expected to place in the hands of the community a means of obtaining fac-simile messages at a rate of speed and with a degree of certainty to which none of the other systems could hope to attain.

None of them pretended to that kind of synchronism which Mr. Delany has established; they nearly all went for a moment and stopped, and then went on again after a fresh impulse.

With some crudely prepared apparatus, Mr. Delany has been able to transmit the despatches which I now show to you, both as actually received and as projected from their photographs on the screen.

From the earliest time, even from that of Bain, when the idea of fac-simile transmission was first brought before the public, it has been recognized how great an addition would be afforded to the practical working of the telegraph if fac-simile transmissions could be given with sufficient speed and certainty. It will readily be seen from the brief history I have given, that considerable effort has already been put forth by ingenious men in this direction.

Two difficulties have heretofore stood in the way of successful fac-simile-transmission; one was that it was slow, another that it was by

by no means certain, since much depended upon the apparatus being kept in perfect synchronism. When I had the pleasure of reading a paper on multiplex-synchronous telegraphy, I remarked that nearly all electricians agreed that when synchronism was absolutely obtained, almost anything requiring mere mechanical accuracy was possible in telegraphy. Fac-simile transmission is one of these. The advantages of a perfected commercial system of fac-simile transmission are manifold; among them are the following; viz., the portrait of a criminal can readily be reproduced and flashed across the wire all over the country. Important autographic despatches may be sent. I have here a despatch to Dr. Wahl, written in a handwriting which can be readily distinguished, and which has been sent over this telegraph:

"DR. WILLIAM H. WAHL,
Secretary Franklin Institute.

"NEW YORK, March 13, 1885.

"Please send me twenty copies report Examiners, Section XVIII.

"P. B. DELANY."

So it would be quite possible to flash over the wires, and send to the newspapers, rough pen-and-ink sketches of any scene of disaster which should occur, along with the telegraphic description of the disaster. I could not help thinking, while Mr. Ives was reading his very interesting paper on "Isochromatic Photography," that I would have liked to have had him make photographs of the messages I have shown you, as the originals are blue prints, and it is difficnlt to obtain a good photograph from a blue print.

The greatest rate of transmission which he has obtained by the aid of the exceedingly crude apparatus, which will give, perhaps, but a third or a fourth of the rapidity of the perfected apparatus, is twelve square inches a minute.

In response to a question from the President, Prof. Houston said the perfected apparatus would probably cover from thirty-six to forty-eight square inches per minute.

OBSERVATIONS OF SOLAR PROTUBERANCES.—In his report of the observations at the Royal Observatory of the Roman College during the year 1883, Tacchini gives indications of epochs of double maxima as well as epochs of single maxima in the solar protuberances of each hemisphere, and he judges from analogy that the irregularities in the apparent contour of Venus may be due to a gaseous condition in that planet.—*Comptes Rendus*, July 15, 1884. C.

Book Notices

THE CIVIL ENGINEER'S POCKET-BOOK, of Mensuration, Trigonometry, Surveying, Hydraulics, Instruments and their Adjustments, Strength of Materials, Masonry, Principles of Wooden and Iron Roof and Bridge Trusses, Stone Bridges and Culverts, Trestles, Pillars, Suspension Bridges, Dams, Railroads, Turnouts, Turning Platforms, Water Stations, Cost of Earthwork, Foundations, Retaining Walls, etc. In addition to which the Elucidation of certain Important modes of Construction is made in a more simple manner than heretofore. By John C. Trautwine, C. E., etc. Copiously illustrated (22d thousand). Revised, corrected and enlarged. By John C. Trautwine, Jr., C. E. New York: John Wiley & Sons, 15 Astor Place. London: E. & F. N. Spon, 1885.

In making a careful comparison between the last (the 22d) edition, and the one that precedes it, the expert cannot fail to be struck with the great improvement exhibited by the present edition. We say improvement, although it seemed almost impossible that the book in its various editions needed any other than, perhaps, such as related to minor details only, and such additions as were needed from time to time in bringing the book down to date. The value of Mr. Trautwine's book has best proved itself by the fact that perhaps seventy-five per cent. of all of those who have occasion to use such a work of reference, prefer it to-day to any other. This is no doubt directly due to the practical and common-sense manner in which Mr. Trautwine treats the subject-matter. A. S.

A HANDBOOK ON THE TEETH OF GEARS, their Curves, Properties and Practical Construction; with Odontographs for both Epicycloidal and Involute Teeth, Rules for the Strength of Teeth, a Table of Pitch Diameters, and much other General Information. By George B. Grant. Published by the Author, 66 Beverly street, Boston, N. D.

This little work gives, in a clear and concise manner, the forms of gear teeth, their mode of construction, their strength, the curves in use, and the manner of laying out the teeth by the use of Willis' Odontograph, as well as by the improved Willis and Robinson. Tables of pitches, pitch diameters and clearances, are also given. Illustrations and examples accompany the explanations, thus materially assisting the student in designing teeth for any purpose. W. B. L.

STEAM MAKING, OR BOILER PRACTICE. By Charles A. Smith, C. E., etc. Chicago: The American Engineer, 182-184 Dearborn street, 1885.

It has been a subject of surprise as well as regret that, in this land of steam boilers, the literature of the subject should be so very disappointing. This is, no doubt, due to the fact that nearly all such works are the productions of men without any practical experience. The result is that we get only a rehash of old books, reports and trade circulars.

What is wanted in a work of this kind, is, that it should contain practical notes on the designing and arrangement of riveted joints, tracing, spacing (both of flues and rivets), and, last but not least, on the best arrangement for the combustion of the gases, both for internally and externally fired boilers.

Mr. Smith's book certainly cannot be said to supply the want. Out of the fifty-three different types of boilers, only two examples of horizontal flue (tube) are shown, whereas this style of boiler is the most common in use in this country.

The author states in the second paragraph of the preface that "in such a work there can be little originality," and that he is indebted to many sources for his information. This will be news, indeed, to the engineer.

The work is arranged in chapters, on the nature of heat, properties of steam, combustion, externally and internally fired boilers (the latter including portable, locomotive and marine), and on the subjects of design, construction and fittings.

These are all proper in their place, but the information that is wanted in a work of this kind, as, for example, the determination of the best pitch and diameter of rivets for a given thickness of plates, and form of joints, is lacking. It is a well-established fact that, as the majority of our boilers are now constructed, the strength of the plates per square inch of section is usually less, to begin with, than that of the rivet; the plates commonly used are liable also to reduction by punching, etc.; while the section of the plate itself is liable also to be reduced by corrosion. It is advisable, therefore, that riveted joints should have an excess of plate section—exactly the reverse of present practice.

This is a point in boiler construction and practice which the author has not touched on at all, and, in view of the present rapidly extending use of high steam pressures, is the most important question in boiler construction.

The part referring to boiler setting, especially for externally fired boilers, considering the fact that this kind of boiler is more largely used in this country than any other, is very scant both in information and illustration.

As a book of reference for what has been done in the past with such boilers as are now in use, it will be found convenient. W. B. L.

THE FALLACY OF THE PRESENT THEORY OF SOUND. By Henry A. Mott, Jr., Ph.D. New York: Printed for the author, by John Wiley & Sons.

In 1877, a Methodist minister, Rev. A. Wilford Hall, published a book entitled "The Problem of Human Life, Here and Hereafter," in which he made an elaborate attempt to prove that several of the generally accepted theories of modern science are devoid of foundation. Among these he included the wave theory of sound. His book seems to have attained some notoriety, chiefly among uneducated people, but is unknown to most physicists. The author claimed to have made some original discoveries in sound, but did not publish them in any scientific journal of recognized standing. He indulged in the most pointed abuse of Professors Helmholtz, Tyndall, and Mayer for refusing to notice him, and offered a large reward in money to any one who could prove his theories false, but without defining any standard by which the wager would be won or lost.

Dr. Henry A. Mott has become convinced that Dr. Hall is not properly appreciated. Being a member of the New York Academy of Sciences, he presented before that body, in December last, a paper on Sound which forms the greater part of the present volume. He is thoroughly of opinion that

the wave theory is false, but he makes no attempt to substitute any other theory. He states in the preface that what he does is "a very bold undertaking" but he has less boldness than his master, who promulgates a theory of his own, that sound is due to emanations of an *immaterial substance*. The master attempts to be constructive; the disciple is only abusively critical, but on his last page briefly promises to give a better theory at some future time. Many of the arguments employed by him are taken directly from Hall's book. To such an extent is this true that any one who reads Hall's chapters on Sound finds in them the destruction of most of the claims to originality that Dr. Mott might otherwise make for himself. He shows some skill in the arrangement of his topics, but very little comprehension of the fundamental conceptions underlying the wave theory, which he thinks has suffered "complete annihilation" at the hands of himself and Hall. It is but fair to add that he gives Hall due credit, by numerous citations.

To outline any considerable number of the objections advanced by Dr. Mott would carry us far beyond the limits of a book notice. He is particularly abusive of Professor Tyndall (p. 25), calling one of his illustrations (Tyndall on Sound, p. 42) "a most childish experiment," and showing how a simple device would have "destroyed the experiment altogether." He exhibits either no conception or a very vague conception (p. 17) of Fourier's Theorem. He agrees with Hall in confounding velocity of wave propagation with velocity of periodic motion (p. 23), and concludes that "if there was the least truth in the wave theory, the sound of a church organ should get up a cyclone which would blow a cathedral into atoms." He holds up to view what he believes to be the falsity of the usual methods of illustrating interference of sound, thinks that beats are in no way due to air waves, and sustains Hall's view that such operation "takes place in the instruments themselves or in their potential and practical sympathetic attraction for each other, without regard to the coincidence or interference of such useless nonentities as these so-called atmospheric condensations and rarefactions" (p. 91). Such sympathy is evidently very "potential and practical." He then cites a remarkable experiment in confirmation of this view, "Suppose, for example, two forks mounted upon their resonant cases and tuned sufficiently out of unison to produce, say, one beat to the second. If sounded in close proximity to each other or in a position of strong sympathetic attraction, a listener a hundred feet away from them will distinctly hear their beats; will, in fact, hear them as far away as the sound of the forks is audible. But let the two forks while sounding be quietly separated only a few feet toward the right and left of the listener, and although he will continue to hear their united sounds in full force, yet the beats will entirely cease, showing that they result from the sympathetic influence of the two forks upon each other owing to their affinity."

Dr. Mott deserves credit for the discovery of mechanical "affinity." If an impatient reader should call such science the product of simplicity or ignorance, the experiment just described is not hard to make. The author is imaginative, if not confiding. Words are sometimes more charming than facts.

Dr. Mott sets forth the discussion, previously given in full by Hall, regard-

ing "The Physical Strength of the Locust," the conclusion of which is that, if the wave theory be true, this energetic little creature amuses itself by giving bodily motion to some millions of tons with its lively chirrup. Of course, no verification is necessary. The locust is quite able to shatter the wave theory.

The most destructive argument, however, that Dr. Mott includes in his challenge to the world of science may be expressed in his own words: "I am willing to risk the fallacy of the wave theory upon the correctness of one single objection, and that is the slow instead of swift movement of the tuning-fork when sounding audibly and its inability to produce sonorous sound-waves at all as required by the current theory of acoustics." This "slow movement" was first discussed several years ago by Hall and Carter. A fork vibrating 256 times per second continues to produce audible sound after the amplitude of its swing has become exceedingly small. A computation is made to estimate this amplitude at the end of four minutes; and it is thence easily proved that the velocity of the prong is very slight, less indeed than that of the hour hand of a clock. And because this is so, the conclusion is reached that no waves could be propagated through the air from such a slow-moving body. The fallacy of such a conclusion is obvious to any one who has elementary conceptions about the measurement of mechanical energy, but neither Mott nor Hall seems to be included in this class.

The book is sensational, shallow, useless, yet sometimes amusing. The fact that its contents were given in the form of a lecture before the New York Academy of Sciences is sufficient excuse for this notice. No scientific society can insure itself against the occasional introduction of pseudo-science.

CRITICAL TEMPERATURE AND PRESSURE OF THE AIR.—Olzewski, having first compressed in Natterer's apparatus some air which contained neither carbonic acid nor watery vapor, introduced it into a glass tube which had been cooled by means of ethylene to temperatures between —142° and —150° C. Under a pressure of fifty atmospheres, there was no meniscus; but on lowering the pressure slowly to 37·6 atmospheres the ebullition of the air became very visible, in the part of the tube which was above the ethylene, and the meniscus was distinctly seen. On increasing the temperature of the air, its pressure also increased, and the meniscus entirely disappeared at a pressure of thirty-nine atmospheres. On repeating the experiment, however, this pressure was found not to be so constant as that at which the liquid air boils, a circumstance which was also remarked in the experiment upon nitrogen. The liquid air does not preserve, in a vacuum, the primitive relations of its elements, the nitrogen evaporating in a larger proportion than the oxygen.—*Comptes Rendus*, July 28, 1884. C.

PNEUMATIC TUBES—The first pneumatic despatch tubes were introduced in Paris in 1867. Eleven years afterwards there were only 33 kilometres in use. Now there are not less than 140 kilometres in the city and 75 offices for sending and receiving despatches.—*Les Mondes*, Nov. 8, 1884. C.

Franklin Institute.

[*Proceedings of the Stated Meeting, held Wednesday, May* 20, 1885.]

HALL OF THE INSTITUTE, May 20, 1885.

WM. P. TATHAM, President, in the chair.

Present—185 members and 6 visitors.

The election of eight new members was reported.

Prof. P. H. VAN DER WEYDE, of Brooklyn, N. Y., read a paper on the "Phelps System of Telegraphing to and from Railway Trains in Motion." The paper was fully illustrated with the aid of lantern slides, and by a working model. The paper, with discussion thereon, has been referred for publication. The thanks of the meeting were tendered to Prof. Van der Weyde for his able and instructive presentation of the subject.

Mr. WM. B. LEVAN read a paper entitled "Railway Facilities of the Past and Present," embodying some interesting facts relative to the early history of the methods of transportation in the United States. The paper has been referred for publication.

Mr. FREDERICK IVES presented a further communication on the subject of "Isochromatic Photography," describing certain recent observations which he had made on the comparative value of various sensitizers in photographing colors in the true proportion of their brightness. The paper was instructively illustrated with the aid of projections on the screen. It has been referred for publication.

The Secretary presented a summary of the work of the preparation for the forthcoming "Novelties" Exhibition, and a report on the World's Fair at New Orleans.

The Secretary reported also that the Board of Managers had approved the proposition of the Committee on Exhibitions to make a special award of a "Grand Medal of Honor," to be given to the "Invention or Discovery shown at the Exhibition which shall be held to Contribute most largely to the Welfare of Mankind." A body of examiners will be chosen by the Board of Managers for the purpose of carrying the plan into effect. They will be men of eminent repute, and will be charged with the duty of making a report to the Board, embodying therein the nomination of the invention or discovery which they may deem deserving of the award herein named. The Board of Managers will thereupon take action on the report and recommendation, and, if approved, the award will be made in accordance therewith. In deciding to award this mark of pre-eminent distinction, the Board of Managers have in view not merely the object of influencing the presence of exhibits of a high order of excellence, but also the traditional policy of the Franklin Institute—the encouragement of Science and the Arts.

The Secretary also reported that the Committee of the Franklin Institute to which the nomination of a candidate for the award of the "Albert Medal" of the Society of Arts, was referred, had decided to present the name of its past President, Mr. WILLIAM SELLERS, "for his invention

of the system of screw-threads, which was approved by the Institute and adopted as a standard by the Government of the United States; and for his numerous improvements in the design and construction of machine tools, which have become models for the makers of all nations."

The President announced the death of JOHN W. NYSTROM, for many years an active member of the Institute, and who served for several terms on the Board of Managers, and was a frequent contributor to the JOURNAL. He suggested some official action in relation to Mr. Nystrom. Mr. H. R. HEYL, seconded by Mr. WM. B. LEVAN, moved that a committee be appointed to prepare a memorial of the deceased, to be placed on the records. Carried. The President appointed Messrs. H. R. Heyl, Frederick Graff and Wm. B. LeVan.

Adjourned.

WILLIAM H. WAHL, *Secretary.*

DECOMPOSITION OF CAST IRON BY HEAT.—Some experiments of L. Forquignon upon malleable iron led him to suppose that cast iron, at a temperature somewhat inferior to its melting point, is decomposed into free graphite and a purer carburet of iron. He accordingly heated cast iron in a vacuum, to a temperature of from 900° to 1,000°C., for several days, without melting or softening. The metal became malleable, and its surface was covered with a dull grayish efflorescence, which produced a mark upon paper or on rough porcelain. The fracture was sometimes of a uniform black, like that of a lead pencil, and sometimes it was dotted with black grains of amorphous graphite, regularly disseminated throughout the mass. It seems probable that this partial decomposition depends upon a tendency to equilibrium between the carbon, the iron and the carburet of iron, the relative proportion of each of these bodies being a function of the temperature. The decomposition of a homogeneous solid into two other solid bodies is a very rare, if not a unique phenomenon.—*Comptes Rendus*, Aug. 4, 1884. C.

THE USE OF FORMENE AS A COOLING AGENT.—Wroblewski having claimed priority for the employment of formene, in producing very low temperatures, stated that his experiments date from the month of March, 1884, while Cailletet did not speak of his own experiments until April. Cailletet replies by a sealed note, which was deposited on December 12, 1881, in which he proposes to apply formene and ethylene in studying the compressibility of nitrogen, hydrogen, etc., at very low temperatures.—*Comptes Rendus*, Aug. 4, 1884. C.

VELOCITY OF THE KRAKATOA WAVE.—Boussinesq, in a letter to M. de Saint-Venant, calls attention to what he considers as the most interesting fact in Verbeek's report upon the great eruption of August, 1883. The wave was propagated by Port Elizabeth, on the southern coast of Africa, with a velocity of 566 kilometres per hour, or 157·22 metres per second. This corresponds almost precisely with Lagrange's formula for the celerity of propagation of long liquid waves when the height of the wave is insignificant in comparison with the depth of the water.—*Comptes Rendus*, May 19, 1884. C.

CONSTITUTION OF CLOUDS.—M. de Tromelin attacks the hypothesis that clouds are composed of vesicles or hollow spheres of condensed vapor. He supposes that every solid body, whatever may be its diameter, retains around it by adhesion a special atmosphere of the gas in which it is plunged; that the thickness of this atmosphere is nearly independent of the volume of the solid body; that the attraction which retains it is within the domain of the molecular forces and is manifested only within very short distances. In this way he accounts for the difficulty of completely removing the air from a tube which is to be filled with liquid. In the case of a vesicle surrounded by its atmosphere the thermal absorption of the water is much greater than that of the surrounding diathermanous air. The atmosphere of the vesicle is consequently expanded and the particle with its atmosphere floats by displacing an equal volume of the circumambient air. The dust particles which are observed in the sun's rays are supposed to be sustained in the same way.—*Les Mondes*, Nov. 8, 1884. C.

RONKAR'S THEOREM.—According to the principle of conservation of energy, every vibratory movement offers an example of the periodical transformation of actual into potential energy and *vice versa*; the total energy alternately becomes wholly actual or wholly potential. In elliptical movement produced by the attraction of a fixed centre, in the inverse ratio of the square of the distance, the total energy is always composed of two parts, one actual, the other potential; the first attains its maximum at the point of the trajectory which is nearest to the centre of attraction, the second at the point which is most distant. E. Ronkar gives the following theorem: In a system of which the movement is periodic and which satisfies the principle of conservation of energy, if the initial conditions of the movement undergo an infinitesimal variation, the increase of the mean potential energy surpasses that of the mean actual energy by a fraction of the latter which is double the relative increase of the period.—*Bull. de l'Acad. de Belg.*, July, 1884. C.

RELATION BETWEEN MOLECULAR WEIGHT AND VELOCITY OF EVAPORATION.—In distilling equal volumes of benzol and water, successively, in the same apparatus and at the same temperatures, it is found that different weights of the two substances pass over in a unit of time. Extensive experiments with water, benzol, chloroform, etc., show that the times for equal weights, at the boiling points, are very nearly in inverse proportion to the molecular weights. C. Schall has examined eleven substances, with very satisfactory results, and he proposes to give the subject a very thorough investigation.—*Beiblätter*, No. 4, 1884. C.

CURIOUS EFFECT OF ASPHALT PAVEMENTS.—It has been noticed that laborers who work barefooted upon asphalt pavements are subject to swelling of the limbs, which has been attributed to the vaporization by the heat of the feet of a small quantity of the petroleum or mineral oil which is contained in the asphalt. The nerves of the feet which govern muscular action and the contraction of the blood-vessels form an extensive and very sensitive nervous network under the arch of the foot where the skin is always thin and the nerves are consequently easily affected.—*Les Mondes*, Nov. 8, 1884. C.

HEALTH EXHIBITION, INTERNATIONAL. LONDON, 1884.

CONFERENCES (as follows):

Bee-Keeping. British Bee-Keeper's Association.
Cobbold, T. S. Parasites of Meat and Prepared Flesh Food.
Cross, C. T. Soap.
De Chanmont, Prof. F. Practical Dietetics.
Domestic Sanitation. Society of Medical Officers of Health. Sanitary Institute of Great Britain. Parke's Museum of Hygiene.
Dwellings for the Poor. Mansion House Council on the Dwellings of the Poor.
Electric Lighting in Relation to Health. Society of Telegraph Engineers and Electricians.
Epidemic Diseases. Epidemiological Society of London.

LECTURES.

Gamgee, Prof. A. Digestive Ferments and Chemical Processes of Digestion.
Meteorology in Relation to Health. Royal Meteorological Society.
Oral Instruction of the Deaf and Dumb. Association for the Oral Instruction of the Deaf and Dumb.
Owen, Edmund. Rearing of Hand-fed Infants.
Sanitary Construction of Houses. Royal Institute of British Architects.
Sanitary Legislation. Social Science Association.
Thudichum, J. L. W. Æsthetical Use of Wine.
Wigner, G. W. Pure Milk.
Wingfield, Hon. Lewis S. History of English Dress.
Williams, W. Mattieu. Science of Cookery.

HANDBOOKS (as follows):

Attfield, J. Water and Water Supplies.
Berdmore, Sept. Principles of Cooking.
Blyth, A. W. Diet in Relation to Health and Work.
Canthi, James. Accidental Injuries.
Cheyne, W. W., Corfield, W. H., and Cassel, C. E. Public Health Laboratory Work.
Duclanx, Dr. Fermentation.
Duff, Harry. Legal Obligations in Respect to Dwellings of the Poor.
Dyke. Acland, Sir Henry W. Health in the Village.
Eassie, Wm. Healthy and Unhealthy Houses.
Edis, R. W. Healthy Furniture and Decoration.
Evatt, G. J. H. Ambulance Organization.
Galton, Capt. D. Ventilation, Warming and Lighting.
Gamger, A. Physiology of Digestion.
Gladstone, Mrs. Healthy Nurseries and Bedrooms.
Goodwin, E. W. Dress, its Relation to Health and Climate.
Guide to Sanitary and Insanitary Houses.
Lakeman, Jas. B. Health in the Workshop.
Lyttleton, Hon. E. and Cobb, G. F. Athletics, Part 2.
Manley, J. J. Salt and other Condiments.
Murphy, S. F. Infectious Diseases and its Prevention.
Old London Street.
Poore, G. V. Our Duty in Regard to Health.
Scott, Wm. B. Cleansing Streets and Ways.
Sparkes, John C. L. Schools of Art.
Thudichum, J. L. W. Alcoholic Drinks.
Warre, Rev. E. Athletics. Part 1

LECTURES.

Ballin, Ada S. Children's Dress.
Blyth, A. W. Old and Modern Poison Lore.
Carr, Henry. Domestic Poisons.
Corfield, Prof. Foul Air in Houses.

Daily Programme. Monday, October 13th, 1884.
De Chanmont, Prof. F. Prevention of Cholera.
Dixon, H. B. Domestic Use of Gas.
Eassie, W. Healthy Town and Country Houses.
Education. 2d and 3d Editions.
Evatt, Surgeon Major J. G. H. Ambulance Organization.
Galton, Capt. Douglas. Ventilation in Connection with Warmth and Lighting.
Gibert, Dr. J. Dispensary for Sick Children.
Graham, Prof. Charles. Chemistry of Bread Making.
Guide to Exhibition.
Hart, Ernest. Smoke Abatement.
Hodgetts, Prof. Anglo-Saxon Dress and Food.
Hodgetts, Prof. Anglo-Saxon Dwellings.
Lakeman, J. B. Health in the Workshop.
Mariboe, Alex. The Danish Dairy.
Morris, Malcolm. Ethics of the Skin.
Morris, Wm. Textile Fabrics.
Official Catalogue.
Poore, G. V. Thrift in its Relation to Health.
Sheldon, Prof. J. P. The English Dairy.
Smithard, Miss. Dairy Management.
Teale, T. P. Healthy Houses.

Heinrich, O. J. Progress of the Manufacture of Soda by the Ammonia Soda Process. 1884. From American Institute Mining Engineers.

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From Bureau of Education.

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From American Institute Mining Engineers.

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Presented by the Board.

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Presented by the Society.

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From the Secretary.

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From the Board.

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